TALKING ELECTRONICS®

A NEW MAGAZINE FOR EXPERIMENTERS

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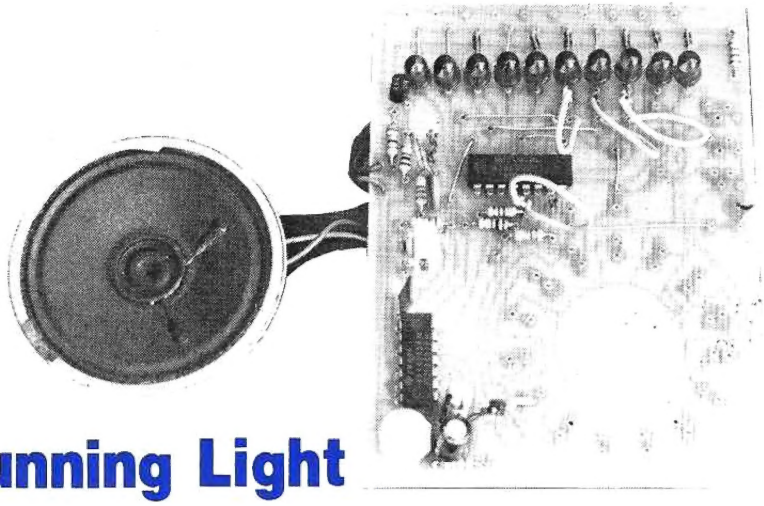
Issue No2.



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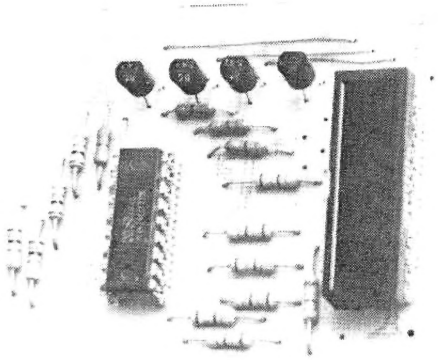
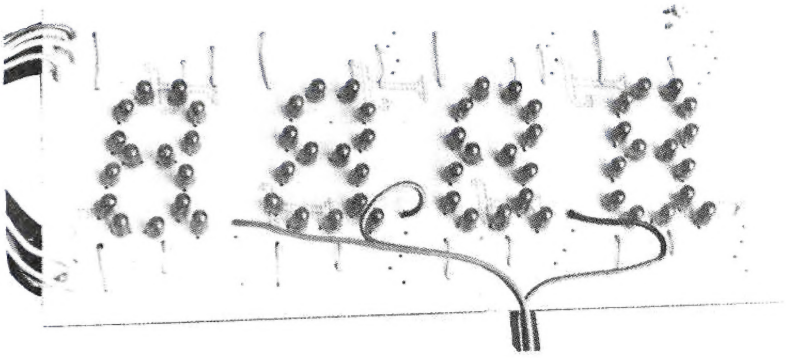
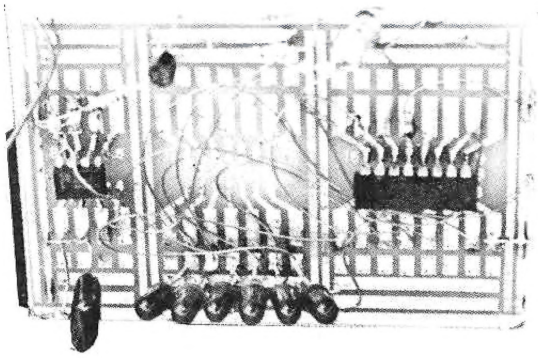


Counter Module

PRE-PAK catalogue INSIDE



7- Segment Display



LED Dice

FREE! 2 TRANSISTORS! See P.27 for details

Registered for posting as a publication – Category B

TALKING ELECTRONICS

Vol.1 No.2

Editorial...

We derive a great deal of pleasure bringing out TALKING ELECTRONICS. The initial response has been very encouraging, so much so, our initial intention of a 32 page issue has exploded to 48 pages. From the letters it seems we have fulfilled a need in the experimenting field. We obviously have not satisfied it fully but at least have made a large dent. Many readers have requested we cover their pet interests such as computers, amplifiers, remote control, model railroad and CB radio.

For the moment we intend to concentrate on simple DIGITAL projects and provide a firm background to understanding this sector. We will also include an occasional article capable of fulfilling a dual role. Projects such as pocket transmitters, 4-amp power supplies, 20-watt stereo amplifiers for $5 and electronic traffic lights are in the pipe-line.

You can see the leaning has been towards instructional material with a back-up of questions to consolidate learning. This is our aim. We intend to lift the hobbyist who is new to electronics and gather in the more advanced with a series of graded articles. We can then extend our efforts to additional fields.

A key factor to positive learning is the tests and quizzes in each issue. These highlight the saying "You may know, but do you know you know?"

Colin Mitchell.

Publisher

TALKING ELECTRONICS MAGAZINE is designed by Colin Mitchell with a great deal of help from Craig Jones in the technical drawing/designing department and Steven in the art department. Designed and Published at 35 Rosewarne Ave., Cheltenham, 3192. Suitable articles should be sent to this address where you will receive full assistance with final presentation.

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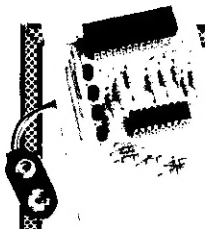
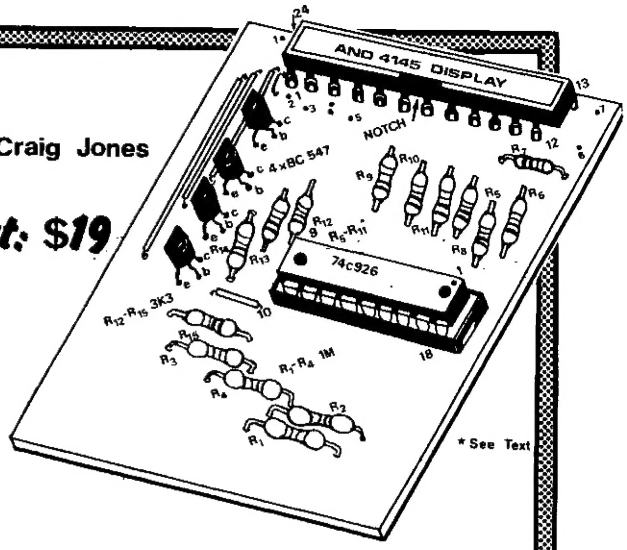


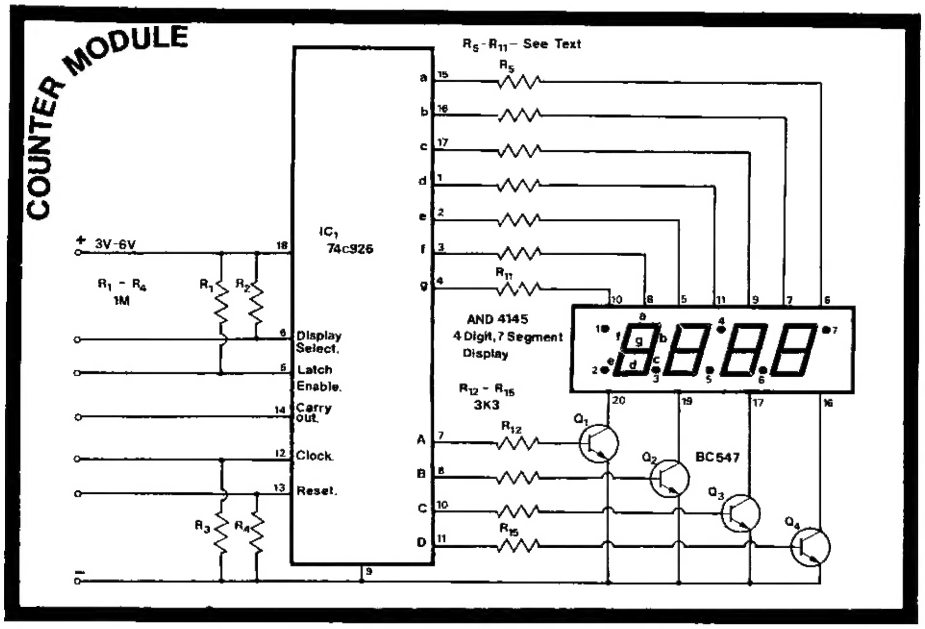
COUNTER MODULE

— Craig Jones

Project cost: $19



A counter is a very handy piece of equipment. It can be used as test equipment, for display, or for experimentation. Our versatile counter module is especially useful. Many variations and adaptions can be engineered around it, as it is a basic building block. It can be used to count from one cycle per hour to nearly 3MHz. To cater for frequencies higher than 3MHz, additional dividing networks can be included at the front end. This would extend the frequency 100 times or more.



Our project will accept 6 different sensors; light, sound, magnetic, unit, oscillator, and infra-red.

Actually the counter module is quite an easy project. Most of the complexity is contained within the two chips and only a few outside components such as resistors need be added. These resistors interface (connect between) the counting chip and the display. They provide current limiting for the display segments and driver transistors. The four resistors at the input of the IC provide pull-up and pull-down. This sets the condition HIGH or LOW on the inputs as many have a dual role.

At first glance this project may seem expensive compared to a pocket calculator. Some calculators have unit-count facilities incorporated into the plus key and this can be extended externally to an oscillator or reed switch sensor. But a Calculator project doesn't give any constructional experience or enable you to add your own read-out. diagram. Nor does it allow you to add your own read-out.

Any of the six sensors can be fed into the 74C926. These will be the basis of the second part of this project. Consider this project as a paying proposition. You have been requested by an engineering firm to design a simple parts counter to tally daily production. Of course it is always possible to bulk-weigh components on a set of ratio-scales, but the management has stipulated an optical counter situated near the operator. You will be required to build a working proto-type for a four week trial-run. How do you think you will fair? The only catch is, you will have to wait for the next issue for the optical sensor.

Any manufacturing firm producing a number of similar items such as plastic parts, packaging of

small items, adding a label to a bottle or hand preparing or de-burring will find a unit-counting recorder of immense benefit. The main advantage of an electronic counter is the number of sensors it will accept. It's a very simple task to adapt optical, magnetic, or audio sensors to count production parts. And most importantly, it is the simplicity of set-up which will appeal to the operator.

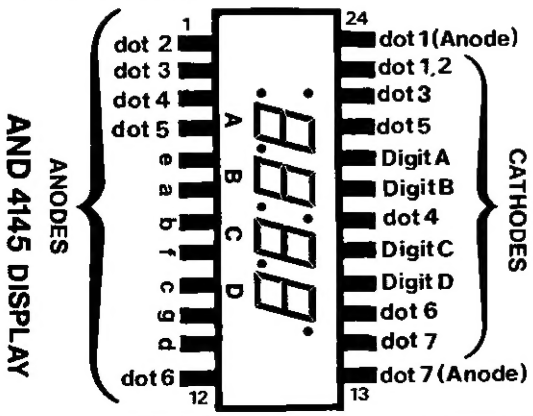
What is multiplexing?

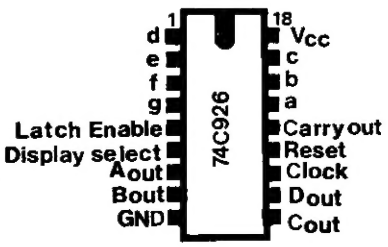
Our four digit "AND" display is multiplexed, but what does it mean?
It is a complex scanning process which we will discuss in a very simple way.
Looking into the display you will see it is capable of showing four figure "eights" and 7 decimal points. If you count up all the segments needed to make each eight, you will have_____ (fill it in) plus 7 dots making a total of at least 35 LEDs. To operate this you would need at least 36 leads.
But the display has only 24 pins. How does that work? In fact 13 of the pins are connected directly to the dots, leaving only 11 pins for all the segments. Each digit has 7 segments, and you would normally assume you would need 4x7 or at least 28 or 29 pins to select any combination of the 28 segments and be able to display any number or letter. Under normal thinking you would be correct. However the technical boys have devised a method which joins the same segment in each digit with the next. This means all segments "a" are joined and all segments "b" are joined together etc. Again your reasoning would tell you that if a figure "eight" were to be presented as the first digit, then all the digits would show "eight". Correct. Now let us advance a little further. Instead of all the other ends (all the cathodes) of the 28 segments being connected together, we join the seven segments of each digit to a drive transistor making four separate items. This time, when the first digit shows a figure eight, we can choose which other digit becomes illuminated with an "eight" by turning on the relevant transistor.

To understand the next portion of our discussion you must change your whole thinking towards displays. They are not a static sign such as that outside a Milk Bar...they are living! They're like a miniature television screen. You know full well that a picture on a TV screen is made up of a single dot flying across the screen to produce 625 lines. And this is repeated 25 times per second. The dot is turned on and off to produce the black and white portions of the picture.
Our "AND" display can be thought of as a TV screen. The four drive transistors are turned on and off sequentially so that if a single segment of the first digit were illuminated, it would light briefly at the first digit then the second digit then the third and finally the fourth digit. In other words it would run the length of the display at about 25 times per second. Now your Persistence of Vision would interpret this as segment "a" in each digit being lit constantly. You cannot see flickering or jumping across the display beyond about 25 times per second.

Follow this experiment. Instead of supplying the display with energy all the time, we pulse it in synchronisation with the turning on and off of the third transistor. The result would be only segment "a" in the third digit lighting up. By using this method we can accurately pick out any segment of the 28 segment in the display. Try visualising how a top segment of digit three and a lower segment of the fourth digit can be selected with one passing of the scan. It merely requires accurate timing of the 7 pieces of information being fed into the display via pins 10,8,5,11,9,7 and 6 to coincide with the digit select transistors.

PIN OUTS:





PARTS LIST:

IC_1 - 74C926

Display - AND 4145

Resistors:

7 - 100R ¼w
7 - 180R "
7 - 220R "
7 - 270R "
7 - 330R "

Use ONLY ONE value SEE TEXT

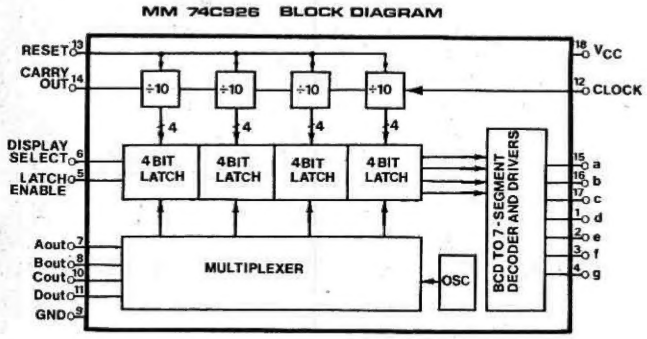
4 - 3k3 "
4 - 1M "

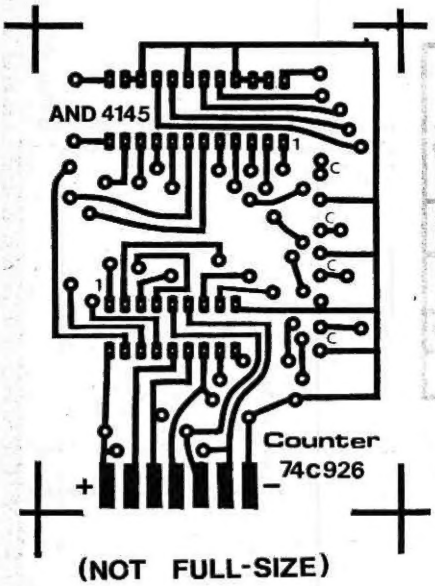
4 - BC 547

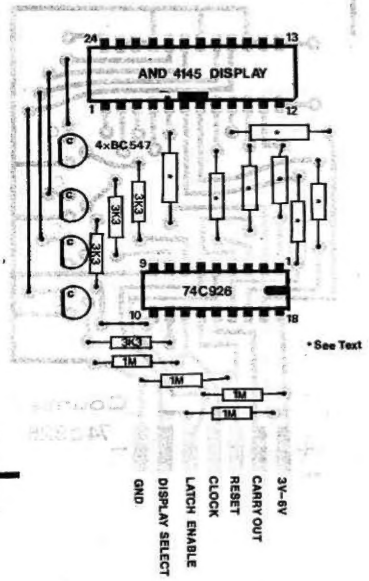
1 - "COUNTER" PC board.

CHOOSING A DROPPER RESISTOR

To limit the current through each segment of the display we need 7 dropper resistors. The value of these resistors will be governed by the supply voltage. Once this is chosen you will be able to select a particular value of dropper resistor. A range of suitable resistors has been included in the kit of parts. You will not be needing all the resistors as some apply to a higher or lower voltage. They are not absolutely critical and a value either side of the one specified will operate quite satisfactorily. The only requirement is for the 7 resistors to be of the same value. Two or three different values will cause the display to be uneven. Fortunately the "AND" display is not quite so sensitive to slight voltage variations as it is constructed with Gallium Phosphide LED's which are a saturating type and produce a very even display somewhat independent of supply voltage.







COUNTER FUNCTIONS:

DISPLAY SELECT:	HIGH - Display shows counter output. LOW - Display shows output of latch.
LATCH ENABLE:	HIGH:- Unlatched LOW - Latched
RESET:	HIGH - Resets to zero
CLOCK: counter counts on the negative edge.	
CARRY OUT:	Goes HIGH at 5999/6000 LOW at 9999/0000

Select the value of R_5 - R_{11} from this list:

SUPPLY VOLTAGE:	AND 4145
3v 4.5v 5v 6v	7 - 100R 7 - 220R 7 - 270R 7 - 330R
	HOME-MADE DISPLAY:
4.5v 5v 6v	7 - 100R 7 - 180R 7 - 270R

The 74C926 counter chip is capable of driving 4 digits. Refer to the block diagram for the sections contained within the chip.
The input frequency appears at the "clock" pin, number 12, and passes through 4 divide-by-ten counters. At each stage it emerges to be fed into a 4-bit latch. The outputs pass to a Binary-Coded-Decimal to 7 segment decoder and driver, where it feeds the display via dropper resistors.

The multiplexing network generates a set of synchronising pulses, one set feeding each of the 4 latches, the other set feeding A,B,C,Douts. The chip contains its own internal oscillator to drive the multiplex which in turn sets the scan rate for the display. This internal oscillator cannot be adjusted which is a pity really, it would be nice to lower the scan to a point where each of the 4 digits can be viewed turning on and off sequentially so the whole operation of the display could be understood.

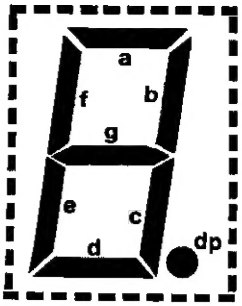
We will be arranging an alternative to the "AND" display, should supplies become difficult to obtain. Don't forget you can make your own 7 segment display and have no supply problems.

cont. on p17.

MAKE YOUR OWN 7-SEGMENT DISPLAY

The advantages:
- ★ Constructed yourself
- ★ LARGER than available displays
- ★ Just needs LEDs and PC board
- ★ Cheap to build

Once again we have designed a SERIES of articles.



7-SEGMENT DISPLAY

—Design by Craig Jones

project cost: $6.00

PARTS

1 - "7-Segment Display PC Board"
15 - 3mm Red LEDs

This first part describes a 7-segment display and presents constructional details to build your own. Initially it will be a single digit assembled on a neat printed circuit board. The board has been designed to take up to four digits with multiplexing but that will be something for discussion later.

WHAT IS A 7-SEGMENT DISPLAY?

The names of most electronic items are self-explanatory. This 7-segment display falls into this category. The most common layout for a single digit appears at the top of this article. Each black segment represents a "bar-type" LED which has an overlay of red plastic containing a cut-out design to give the effect of a figure eight. When various combinations of LEDs are illuminated, we obtain the numbers from 0 to 9. The following diagram shows how this is done:

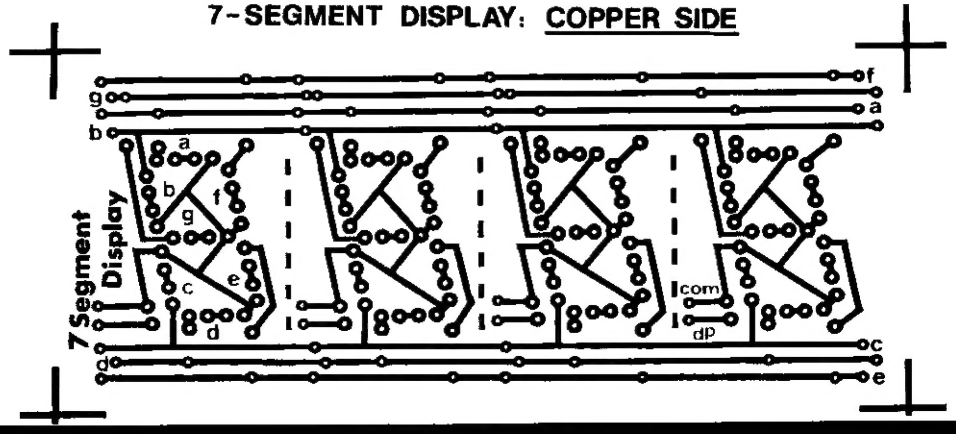
How do you tell if an unmarked display is common cathode or common anode? It's quite simple! You will need 2 penlite cells, a 100ohm resistor and 2 leads with alligator clips. Begin by attaching the negative lead to any pin on the display. Touch each other pin with the 100 ohm resistor. You may or may not find one segment lights up. Keep progressing along the display with the negative clip until you find a position where every segment lights up in turn as the resistor touches the pins. This test shows you have a common cathode display. After all, the circuit you are using is similar to the lower display circuit on the back page DATA shet.

If no segments light, try reversing the leads. When all the segments light, you have a common anode display.

Each segment is given a letter to facilitate easy identification, especially when troubleshooting. The decimal point is represented by "dp" and is handy for decimals or as a seconds dot. Segments b,c represent 1, segments a,b,d,e,g, represent 2, through to "0" being represented by a,b,c,d,e,f.

Some driver IC's provide a top to the number six and a tail to the number nine, as shown in the diagram. The output of other IC's exclude this feature. It depends entirely on the driving network built into the chip and cannot be altered.

7-SEGMENT DISPLAY: COPPER SIDE



7-Segment Display

Light Emitting Diode displays are made in two basic styles. Common cathode and common anode. With the first type the cathode of each LED is connected together to form a common line. To create a common anode display, merely reverse each LED. Our display will replace any available unit, it just depends on the orientation of the LEDs. Here is a list it will replace:

COMMON CATHODE DISPLAY:

FND 357
FND 367
FND 500
FND 800
DL 704
DL 750
MAN 1A
MAN 10A
MAN 4740A
MAN 6750
MAN 74A
Z-4103

COMMON ANODE DISPLAY:

FND 350
FND 360
HP 5082 7620
" 7630
" 7640
" 7650
" 7660
" 7670
DL 707
DL 727
DL 747
MAN 52A
MAN 53A
MAN 72A
MAN 73A
MAN 82A
MAN 4710A
MAN 6730
Z-4117

A side benefit of the 7-Segment layout is its ability to form letters of the alphabet. Use the space below to see how many letters you can create using the standard layout at the beginning of this article. Try producing both upper and lower case letters. You will be surprised how many can be formed:

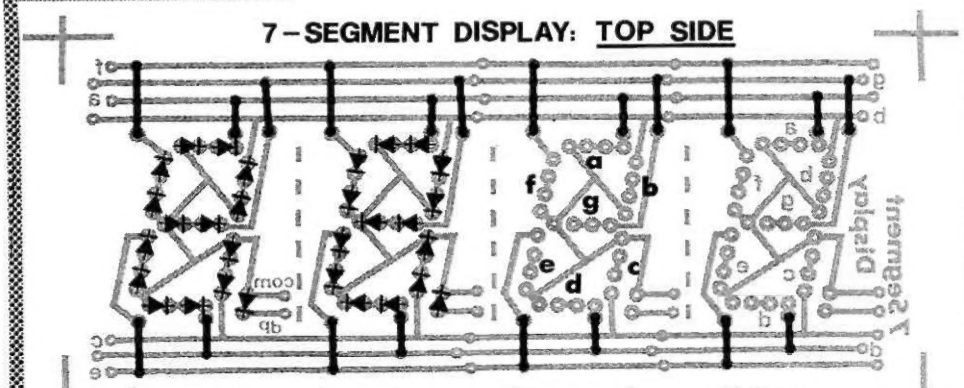
By itself, the display isn't much fun. You need to connect it to a driver IC to get any affective results such as numbers or letters. The driver is a set of transistors which turn on the display segments in groups to produce the numbers 0 - 9. These transistors receives their "turn-on" information in binary form in which the signals will be as HIGHs and LOWs. To create the numbers 0 - 9 from say a push button we need to pass through a number of stages. It is not possible to merely count the number of times a button is pressed to display the number on the module. The various encoding and decoding stages will be discussed in the next section. They are quite involved but extremely interesting. The circuit we will be presenting will contain separate IC's for each stage. Unlike the counter, which contains all the sections within the one chip, this series is designed to teach you in stages.

CONSTRUCTING AND TESTING

The PC board is designed as a 4-digit module. It can be cut between the digits to produce a single or multi- digit display and is designed for multiplexing. This series uses a single digit with 15 LEDs and it is suggested that the balance of the board be left attached for later extensions. Connect the 15 LEDs as shown in the diagram to produce the common cathode display. Keep the soldering neat and snip the leads at the solder line. The digit can be tested as discussed earlier with 2 penlite cells and 100 ohm dropper resistor. You will notice pairs of LEDs are connected in series to give the effect of a rectangular LED. Ideally this display needs a transparent red perspex cover-plate and should be viewed from a distance since the digits are fairly large. It is designed to be seen across a room and will be useful for such projects as clocks and lap counters.

Build the display now!
Wait for the next issue....

7-SEGMENT DISPLAY: TOP SIDE



Common Anode Display **OR** Common Cathode Display — Component Side Letters a-g — Pattern Side Letters a-g

MOLEX PINS

Both the 74C926 and the AND 4145 display are mounted on molex pins. We have found this to be a fairly successful form of mounting as the 24 pin display has different in-line width to a normal 24 pin IC socket. Molex pins also allow you to remove both chips for other projects as most of the cost is centered in these items. The 4-digit 7 segment display described in the next article is fully compatible with this project and the AND display can be substituted with your own home-made version.

MOUNTING THE PARTS

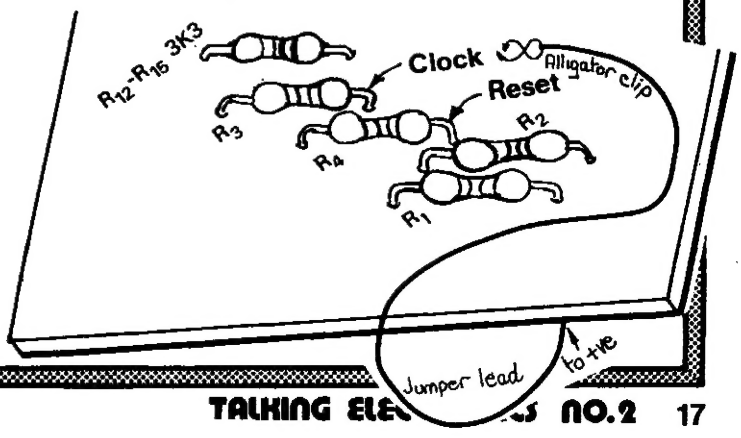
Commence assembly by fitting the molex pins. Cut them into lengths of the exact number of pins required. Push into place and solder quickly and neatly. Bend the unwanted runner backwards and it will break off from the pins. Fit the 4 transistors, 5 jumpers and battery leads. Finally solder all the resistors, including the 7 dropper resistors chosen from the enclosed list.

Now comes the two expensive parts. Locate the dot on one corner of the 74C926. Do not go by the lettering or numbering on the IC. It is not always printed around the same way. Only go by the tiny dimple or dot or key-way in one end. The AND display has a locating mark as a notch or recess in its lower side. Refer to the drawing. With these in position, it is ready for testing.

TESTING

Connect a lead with an alligator clip to the positive rail. This will be your test lead. Connect the battery or power supply and the display will illuminate with 0000. Tap the alligator clip onto the resistor marked "clock" and the display will register 1 or maybe 5 or 6 depending on the number of spikes it detected. You can reset the counter by touching the resistor marked "reset".

Next issue we will provide some experiments and details on input sensors.



.....Continuing the

EXPERIMEN

LED DICE

...WITH SLOW DOWN

PROJECT SIX

Each project in this series needs just a few extra components in addition to the previous project to create a completely different circuit and add a new dimension to the possibilities of electronics. This is one such circuit.

Being electronically minded, have you ever wished you could throw away the old dice used in snakes and ladders and replace it with an electronic dice? Well now you can. With this LED DICE the full realism of waiting for a dice to stop rolling or a spinner to stop spinning is re-created with an electronic circuit. It works like this: after placing your finger on the TOUCH PLATE the LEDs begin to flash rapidly. After a second or two they reduce speed to a running sequence. Then they slow down to a walk and finally a crawl. At this stage you are hoping they will jump one more step to make a six. You're in luck! It jumps to a six! But wait, the capacitor may not be fully discharged. You will have to wait a few more seconds to see if the 555 oscillator will clock the CD 4017 one more step. It does. You lose. You get a single solitary ONE for your turn.

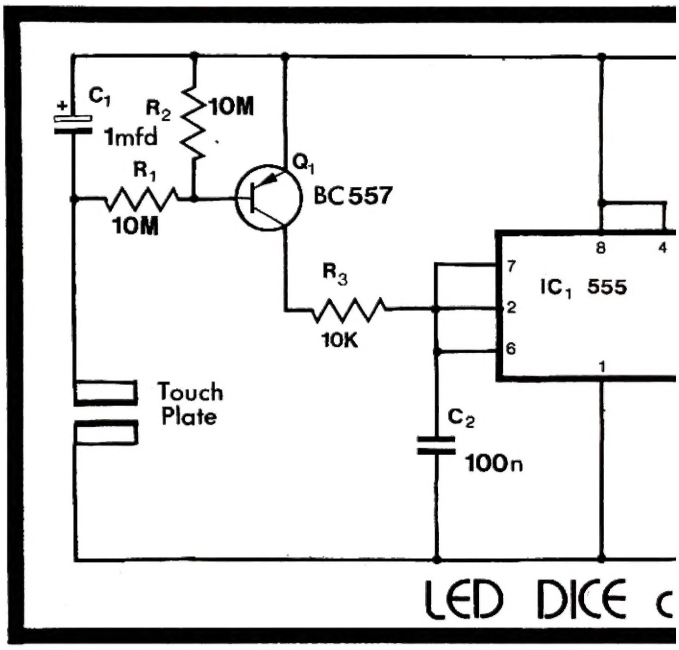
That's the luck of the game. I've never been lucky at cards, dice or poker but I'm sure this game will bring you luck. Even if you don't win at Ludo or Monopoly you will generate a lot of interest from your family and friends - especially since there is no way of "loading" the circuit; it gives a completely random unbiased result.

How it works:

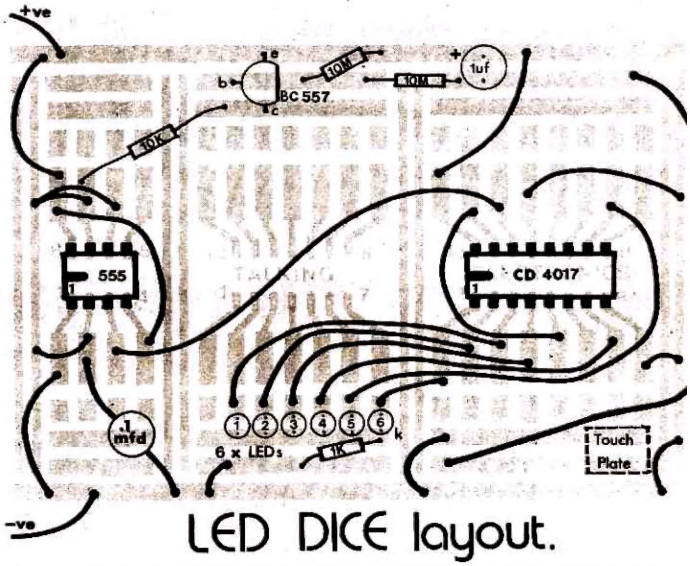
When the battery is connected, the BC 557 transistor Q_1 is biased off via resistor R_2. This means that no voltage will be present at the collector. When the TOUCH PLATE is touched with your finger, C_1 charges and provides a base-emitter potential to turn on Q_1. This potential must be higher than the turn-on voltage of .6v, to turn on Q_1. The collector now provides a voltage at its output. Pin 7 of the 555 timer detects this voltage as described in the beginning of the series. It will oscillate at a frequency determined by the voltage on pin 7 and the value of C_2.

When your finger is removed from the TOUCH PLATE the voltage on capacitor C_1 is gradually removed via the two 10M bleed resistors. As this voltage reduces, the base voltage reduces and the transistor provides a reducing voltage at its collector and also on pin 7 of the 555 oscillator. Thus the output frequency of the 555 slows down and finally comes to a complete halt.

The output of the 555 drives a CD 4017 decade counter which lights each LED in turn. We are using 6 of its 10 outputs. So that only the first six are clocked, the 7th output is connected to the reset pin number 15.



As the decay of capacitor C_1 is exponential, the CD 4017 is clocked slower and slower so that suspense is built up when the LEDs are about to stop. You will never quite know whether the CD 4017 will clock just one more time or sit on your lucky number six!

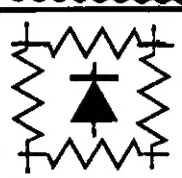


JUNIOR PUZZLE PAGE

How do you begin to learn electronics? By playing and experimenting! This page is for beginners. These simple puzzles will start you learning and thinking. Try them.....

1. The border around this page is made from a chain of diodes. There is one odd-man-out, Can you spot it?

2. There are 43 diodes on the inner circle. How many diodes will fit onto the outer circle? Use the same spacing between diodes as shown.

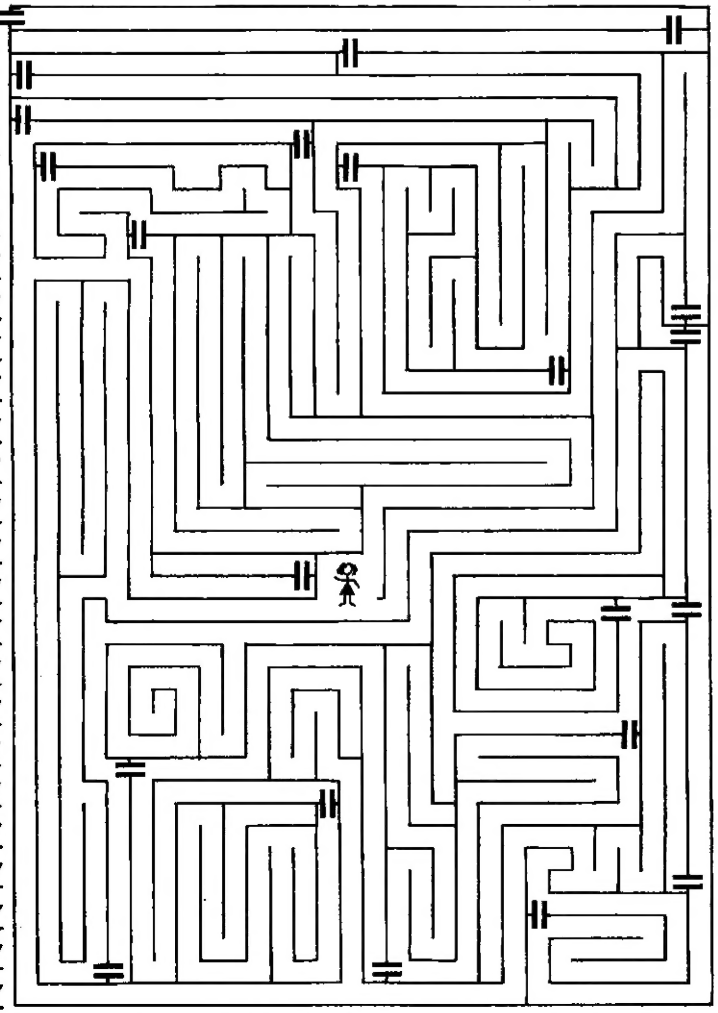


3. Do you look but don't see? What can you see in this diagram? Turn it around.

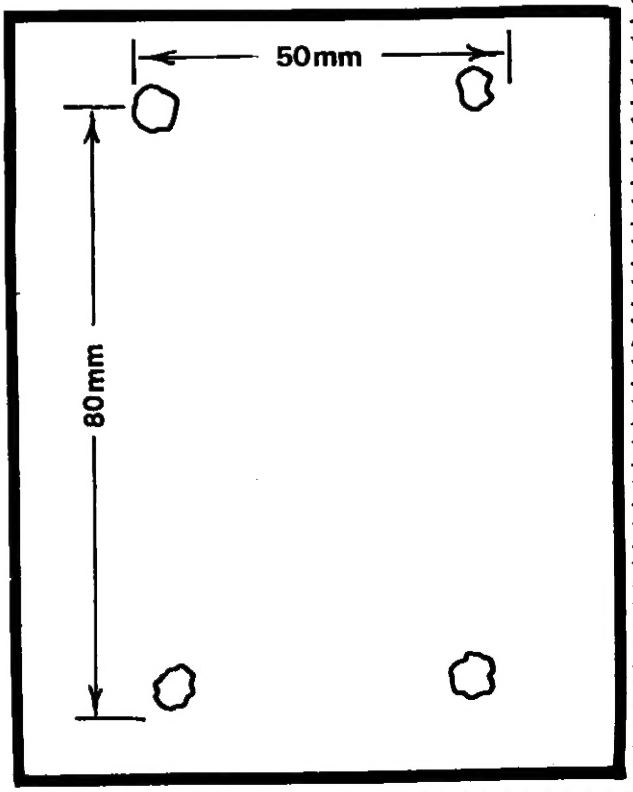
4. A square field made from four resistors encloses one diode. How many diodes will eight resistors enclose?

5. Help Granny Diode out of the Capacitor Maze. Start in the middle and work your way out.

OUT



6. I have a zippy box and wish to cover it with a piece of clear perspex. The only piece I have has 4 holes in it as shown. How can I obtain a perfectly clean piece of perspex 80mm x 50mm from this damaged sheet?



SHOP TALK

— CONDUCTED BY THE EDITOR

Starting a magazine is like starting a whole new career. The effort required to start such a venture is enormous. There are so many separate departments to organize. Writing, typing, drawing, layouts, printing, distribution, advertising, accounting, etc. etc. Most of these are now settled. We are beginning to get some feedback from shop sales and mail order sales. Together with letters, calls and discussions it looks like being a real winner. Parts sales and magazine sales have been very encouraging and have fortunately been above the estimates of two consulting firms. So many letters of appreciation have said the same thing, viz:the need for a magazine containing constructional projects for beginners with a back-up supply of readily available parts. Some have backed this by ordering every item on the ORDER FORM page! I think that speaks for itself. Talking about speaking for itself. The magazine will only talk if you show it to a friend. I know it's a great danger lending the magazine. More often than not it's never returned. To overcome this I have a plan for the third issue. Many readers value the magazine so greatly that they do not want to cut out the order forms..they make a photocopy! A promotional venture will be conducted in issue three. We will include a copy of issue No 1 in the centre for you to give to a friend. I know you will choose wisely who you will give the magazine to as the introduction will gain you a friend for life. If only I had a magazine such as this when I was venturing into electronics...I would be 10 times more advanced now!

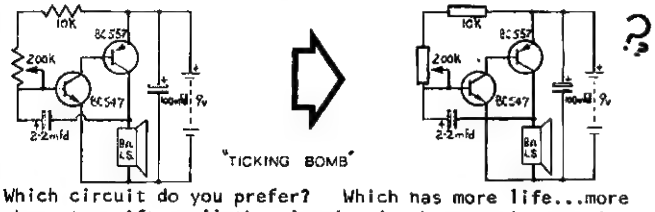
CORRECTIONS TO VOL1 NO1

Page 6: The output sequence in column 3 line 3 should read 3-2-4-7-10-1-5-6-9-11. The diagram is correct.
P 19: Experimenter Deck Parts List should include 24 Red LEDs and 1 green LED. The total kit price becomes $11.50.
P 34: The link below pin 1 of CD 4017 should be higher as shown in issue 2. Actually it is not used until project 2. The diagram in issue 2 has been corrected.

The LED ZEPPELIN circuit on P11 shows incorrect gates for a CD 4001. It should show 3 NOR gates. Change it NOW! Also on P11, under HOW THE CIRCUIT WORKS, we said the circuit consists of a three-inverter CMOS oscillator. Even though the NOR gates are wired as inverters we should be more specific and say: WIRED AS A RING OF THREE CMOS CLOCK OSCILLATOR. In addition, the PC board has pins 11, 12 and 13 left unconnected. As with all CMOS devices, all unused gates should have their inputs connected to ground or V_{SS}. This means pins 12 and 13 should be connected to pin 14.

LETTERS

From our assortment of mail this month we received an interesting letter from Mr. T. Baitch. He is concerned about our choice of symbols for resistors, diodes and crossing points for conductors. He suggest we should use the symbols as stipulated by the SAA. This would mean a typical circuit such as the TICKING BOMB would alter to:



Which circuit do you prefer? Which has more life...more character. After all, the circuits in the magazine are its most important feature. They should instantly present a mental picture of the function of the circuit.....without weighing you down with symbol intrepretation. I know I was brought up on zig-zag resistors and jumpers for non-connected wires and I feel there can be no mistaking their function. Since most of the symbol-changes have been introduced to simplify circuit drawing and not to improve them technically, I am not prepared to accept them for this reason alone. To me a symbol must give an instantaneous impression of its function. I think the old symbols do this perfectly. Your ideas on this would be welcome. I hope to get a cross-section from old and new readers so we can analyse the results.

ARTICLES

Our reference to a career and submission of articles for publication received an encouraging response. The range and suitability of projects was in line with our format, namely simple digital designs. However they all required a degree of re-write and sprucing up before final presentation. Accordingly I have formulated a short list of rules for writers:

1. Don't write run on sentences not using commas as they are hard to read.
2. On the other hand, don't use commas, which aren't necessary.
3. Its important to use apostrophe's correctly.
4. Verbs always has to agree with their subjects.
5. Don't use the word "then".
6. Try to not ever split infinitives.
7. Proofread you copy carefully to see if you any words out.
8. When using hyphens at the end of sentences a-lways hyphenate at syllables.
9. Correct speling is essential allways.

OK then lets get to work and see what projects you can come up with for the magazine as we like to see new ideas coming into the establishment and you will receive a small reward for your efforts as described in last issue providing your article is good enough that is.

ANSWERS TO JUNIOR PUZZLE PAGE

1. The bottom right-hand corner contains the reverse-biased diode. 2 marks.
2. CIRCLE OF DIODES: If you guessed the answer, no marks. If you measured the number of times the set of four diodes would fit around the outer circle...3 marks. If you worked out the ratio of the diameters of the inner and outer circles you would know the diodes would be in the same ratio. 4 marks
   If you drew a line from the ends of the outer 4 diodes to the centre of the circle and found the ratio to be 4 diodes to 3 diodes you would conclude that the outer circle would contain 4/3 x 43 or 57 diodes 6 marks.
3. 4 diodes would be enclosed by 8 resistors. 2 marks
4. Finding your way out of the maze: 2 marks
5. If you see one black and one white man looking up and one black and one white looking down, give yourself 4 marks. You should be able to see the same when the circle is turned around. This indicates you have 2 different depths of focus and is vital.
6. If you bought a zippy box and placed it on the sheet, give yourself 4 marks. If you tried with pen and ruler or mathematics. Give yourself 2 marks. In this world we need more practical people and less theorists.

HOW DO YOU RATE?

As an experimenter you will be required to actually participate in producing each month. It is not sufficient to get a vicarious pleasure from the magazine. You need to apply yourself. See how you score from last month:
At the end of the magazine is a simple quiz. If you filled it out last month, give yourself 10 points.
Applying yourself is an important part to learning. Saying "I'll leave it till tomorrow" doesn't benefit you at all. Just reading doesn't help either. To a practical person, like yourself, reading only gets you 10% of the way. Constructing adds a further 30% while another 60% is added when a fault develops during construction and you are required to "trouble-shoot" the project and locate the fault.
If you constructed a project from last issue (or even 2 or 3 projects) give yourself 20 points.
If you sent away or purchased additional components, give yourself 10 points.

How did you score? Add up the marks or points and give yourself a rating out of 60.

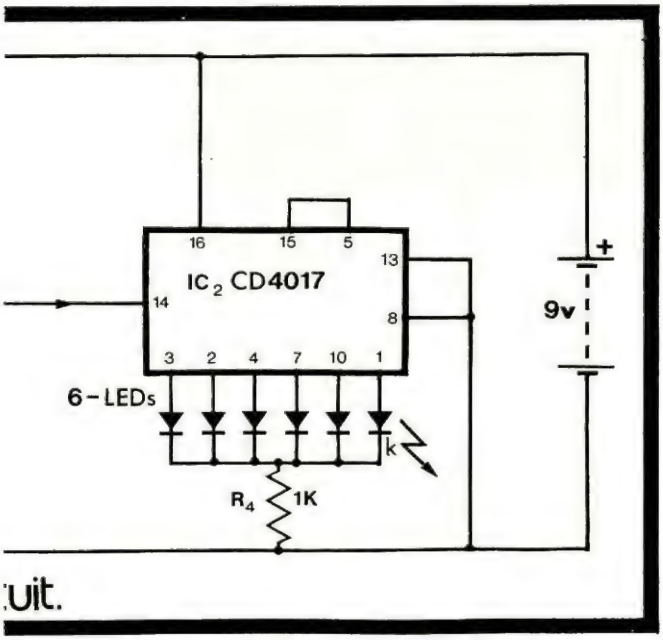
series

TER BOARD

mkI

Project cost: $2.50

After building project five.



cuit.

Building the circuit:

The idea behind this progressive series is to add to each of the previous projects to make a more complex project. This way you will be adding a minimum of components and building new ideas at the least expense. Remove the HEADS and TAILS LEDs from the previous project and all the other parts which will not be needed. Notice that some of the wiring will remain in place so refer to the layout diagram before starting. Fit the six LEDs in the centre of the board as shown. They will need connecting wires to the output pins of the CD 4017 so follow the layout diagram carefully. Solder the other components in place and re-check all wiring. Connect the battery and the circuit will come on with one LED illuminated. Touching the TOUCH PLATE will cause the LEDs to flash at a very fast rate and gradually slow down with just one of them lit.

We claim that the circuit is unbiased. But don't take our word for it. Complete your own statistical analysis of the circuit by taking 100 samples and putting the results in the following table:

No:	Count:	Total
1		
2		
3		
4		
5		
6		

Each time the LEDs stop, place a stroke in the appropriate space thus: / after each four strokes: //// the fifth stroke is placed across the four thus: 𝍸 This makes the final counting easy as they are now in groups of five. Look at your results. Are the totals of each LED nearly the same?

In an article to be presented in a few months, we will be adding a couple more components to this circuit and presenting it as a complete project on a printed circuit board. So wait for it.

Parts list:

R1	resistor	10M	¼watt
R2	"	10M	"
R3	"	10k	"
R4	"	1k	"
C1	electrolytic	1mfd	16v
C2	capacitor	100n	100v
Q1	transistor	BC 557	
IC_1	timer IC	NE 555	
IC_2	decade counter	CD 4017	

LED_1 - LED_6 Large Red LEDs

battery clip
9v battery
approx 30cm hook-up wire

"Experimenter Board 3-ICs"

LED DICE

○○○○○○
1 2 3 4 5 6

or

LED DICE

○○○○○○
1 2 3 4 5 6

"Cut-out" display cards

TV Servicing

WHAT MULTIMETER?

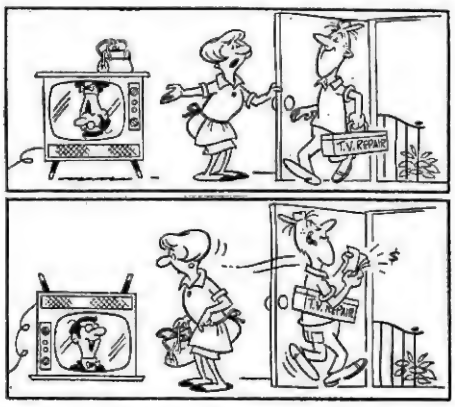
These articles come from a practicing TV technician and revolve around TV problems. But they apply equally to any type of servicing such as amplifiers, CB or car radios.

The first worry for anyone wishing to start in the field of repairing is "What multimeter should I buy?"

I will answer this with 3 true stories on multimeters.

On my first day in a service work-shop I met a technician named Graham. He was the most incredibly capable technician I have ever known and the most amazing. Never once in the two years I knew him, did he ever use any test equipment what-soever. (I must add it was in the days of black and white valve sets). He preferred only bench work and you will see why. A set would be brought to him and in a flash the back would be off, the chassis lifted out and put on test leads. We extended his ability a bit on each of his jobs because the sets we gave him were genuine work-shop jobs in which the road technicians had tried all the valves and searched for any obviously burnt out parts. Within a short time Graham would say "that's it" - up would come the picture for an instant and he would pull his hand out of the TV. His secret repair tool was his two fingers! He would feel around the boost section locate the high voltage resistors and bridge each one with his fingers to create approximately the same resistance as the burnt out resistor and so the height would be restored. In a similar manner he would locate faulty or leaky capacitors in the sync section or vertical linearity and say "replace this one, this one and this one..." Invariably they fixed the set. I used this method for nearly 10 years after that. It does work. You can adjust the resistance of your fingers from 500k down to less than 50k and simulate a leaky capacitor. If the picture fault worsens when you place them across a particular paper capacitor it should be replaced. If the picture develops another fault, the capacitor is possibly ok. (paper capacitors were the biggest culprits). I have never been quite as game with the high voltage side. I prefer to use a 2M2 resistor on test leads for this.

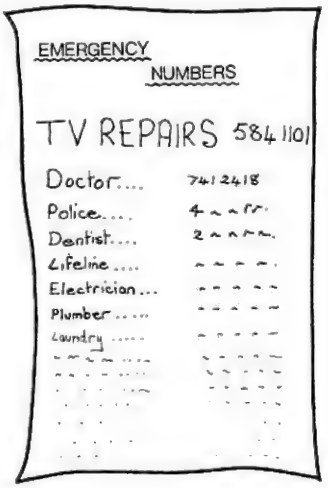
The second story comes from Bert...a TV tech living some 10 miles from me. He had just recently bought a 100k ohms per volt FET voltmeter and was using it on a Thorn valve TV which had a fault in the EHT section. He applied the meter to the grid of the 6CM5 valve and got a high positive reading. Naturally he thought the oscillator or output stages were at fault and spent many hours replacing every part in the two sections. Still the high positive reading persisted. At this stage he came to me with the set and proudly displayed his new meter. My first test was to check the grid voltage with my 20k ohms per volt meter. Sure enough it was correct at -35v. The fault was in a boost capacitor and the set was fixed in 5 minutes. Bert had learnt his lesson. He returned the meter the same day and bought a cheap $25 special! The meter was in fact picking up stray hum and EHT voltage from the EHT transformer. The meter was far too sensitive.



The third story comes from economics. The first meter I ever bought had a sensitivity of 1k ohms per volt. It lasted through 2 years of rough use repairing 100's of TV's before the needle began to stick. My next two meters were 10k ohms per volt. They lasted a few years also. I recently bought a taut-spring multimeter of 30k ohms/volt - it lasted one week and the movement siezed up. The core shifted and jammed the movement. It always happens. The expensive items get damaged first. I remember buying an expensive multimeter last year and dropped it within a month.

This all leads me to one conclusion. For repair work you only need two fingers - I mean a cheap multimeter in the price range $25 to $35. Sensitivities of 10k ohms/volt to 30k ohms/volt are quite satisfactory. Digital meters are an unnecessary luxury. Meters are bit like watches, who need to know the time to the second or a voltage of 35.05v?

OF COURSE YOU DON'T TRY THIS YOURSELF!!!!!



DRY JOINTS

Don't be mistaken, dry joints are one of the most prevelent single fault in colour TV servicing. They account for between 22-30% of all calls. Some TV sets ONLY suffer from dry joints. To back this statement may I say that to date I have never put a replacement part into at least two brands of colour sets. Their only fault has been poorly designed double sided PC boards which suffer from dry joints. The pin which connects the top track to the underside of the board tends to expand and contract during operation and eventually produces a dry joint.

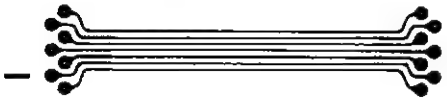
This chapter reveals one of the most heavily guarded secrets of TV servicing. It is an insight for anyone wishing to take up colour servicing. Very little has been released in the past on dry joints mainly due to the difficulty in describing accurately their occurance and cure as told by an "old hand". Secondly, and possibly most importantly, their release has been avoided to prevent customers seizing the opportunity to express a little "knowledge" on a subject of which they know nothing.

...TV Servicing

There are five types of dry joints and five different attitudes to diagnosing them. A competent TV serviceman can be recognised by his approach to locating troublesome intermittent faults.
Here is a brief outline of how these dry joints occur and a proven method for locating them.

Some dry joints are classified as thermal faults. By this we mean the set will operate for a specific length of time then fail. This is due to the heat build-up in the set expanding the components and their leads a few thousandths of an inch (or even millionths of an inch) to create an opening or crack between the component lead and the PC board. This may result in the sound dying away or the picture closing to a line across the middle or both the sound and picture going off together. A bang on the back of the set generally restores full operation or alternately, turning the set off for half an hour will bring it back to life.

Believe me, finding intermittent faults is very time consuming and after many years on the road I have simplified the problem considerably. I let the customer do all the watching and testing. For two reasons I never take a TV out of the house. Apart from the damage caused to large sets in the transportation and the heavy lugging required, the real reason is that movement will generally heal the intermittent fault and it may take weeks for the fault to re-appear in the workshop.
"Soak Testing" a TV (watching the set with the back on) is very expensive and I have the sets generally do not fault in my work-shop! The second major point against removing a TV is the customer resistance. Most customers do not like their set removed from the house.



SO WHERE DO YOU START?

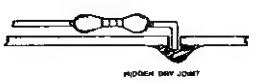
The following 5 points will help you diagnose intermittents on-the-spot but in most cases you will be guided 99% by past experience.

5 TYPES OF DRY JOINTS

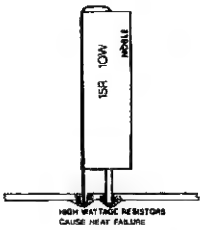
1. An unsoldered joint. This is easy to spot. A component lead which has never been soldered on a PC board or tag strip is obvious. (I once fixed an unsoldered resistor attached to a tag strip on a 15 year old B&W set. It had faulted only after 15 years!) Use a hot iron when soldering the component to the board. Look for any other un-soldered connections.

2. Dirty Component Lead. The diagram shows a component which has not been pre-tinned and the solder does not "take" to the lead. The component should be removed, cleaned, tinned and re-soldered. If in doubt about the solderability of the lead, use a new component.

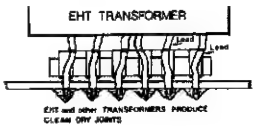
3. Hidden Dry Joint. In the diagram, the component does not pass through the board sufficiently to pick up the dip soldering process or the lead is dirty...creating a hidden dry joint UNDER a perfectly good external soldering connection. Moving the resistor will make it come away from the board.



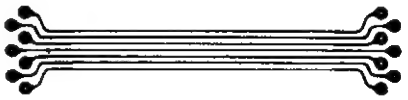
4. Heat or Excessive Current Failure. In this case the lead has been cut too close to the body of the resistor, allowing heat to flow into the solder connection, thus gradually destroying it and the surrounding PC board. If a fairly high current flows through the connection, the joint can develop heating troubles within itself, gradually failing and accelerating the process until finally burning itself out.



5. Expansion and Vibration Failure. Leads from transformers or coils can create very clean dry joints due to the high-frequency vibration of the transformer along with slight expansions and contractions, creating a pushing and pulling effect on the joint or joints until finally they become lose. This can also be due to insufficient solder forming the original



connection during dip soldering. Use plenty of solder when re-soldering and make sure the iron is hot.



Dry joint problems are so complex that the same faulty joint may create six different effects on six similar sets. Their location requires extreme skill and patience. I once waited 45 minutes in a customers home for a fault to occur. When it did occur, I walked over to the set. This created enough vibration to fix the set for three days. (no, I'm not an elephant!) So how do you go about locating these faults? As I said, 99% is prior skill combined with lots and lots of LUCK. This is the skill part:

1. Inform the customer to turn the set on and have it faulting when you arrive at his home. You need to be promptly on the spot as some faults create excessive heating or even picture tube burn lines. Being on mobile 2-way is a great advantage. If a light tap on the cabinet remedies the problem - ask which side of the set responds best. A very light tap will mean the vibration created when taking the back off will heal it - so ask as many details as possible before leaving your workshop.

2. With the set still on, remove the back. If the set comes on, bad luck. Stop immediately and wait.

3. When the set does have a positive fault - place a large mirror a short distance in front of the screen so that it can be viewed from behind the set. When making any tests on the chassis such as tapping or freezing, you will need to look in the mirror constantly as it will be your certain guide to locating the vicinity of the problem.

...TV Servicing

4. Turn up all controls, including the colour to maximum. From the lack of picture and/or sound, you will need to divide the set into approximately four sections, something like this:

   Black screen and no sound - power supply or EHT section.
   No sound but picture ok - sound section.
   Weak snowy screen - tuner or IF strip.
   Black screen,sound ok - EHT section.

   The above is greatly simplified however you will need to ask yourself whether it is a power supply fault, sound fault, high voltage fault or tuner fault and concentrate on this particular section.

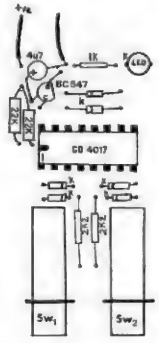
Each set differs as to fault locating and it would take 100 pages to list all the methods of attack. As a general rule, I use this method:

1. With the set still on, remove the back carefully. Use a can of "FREEZE" (compressed carbon dioxide) to spray accurately all over the PC board starting at one end of the soldered side and working systematically over the board. Cover every board in the set. Next spray each and every component with the CO_2. (I have never had it damage any components, even when it freezes them to almost absolute zero - but keep the nozzle a little distant from the parts all the same.
2. Obviously you have been inspecting the soldering while spraying. This time I suggest making a closer inspection - especially around the pins of EHT transformers, switch-mode-power-supply transformers and high wattage resistors. Look for any burn marks, unusual or poor soldering and re-solder any suspect connections. It is best to solder with the set off, so before making any repairs, switch the set off for 30 seconds then on again to see if the fault is self-healing. Once you are satisfied the set remains faulting you can re-solder a few connections at a time, then turn the set on.
3. Some faults do not respond to freezing or inspection. For these intermittent joints you will need low-level illumination and a plastic handled screwdriver. If the PC board is large and mounted on a thin frame it can be twisted by holding the upper and lower corners of the board. This is extremely dangerous because you are using two hands for this operation. Make absolutely certain that you are just touching the blank PC board or the metal frame-work as the grip you are applying will allow any voltage over 100v to become quite lethal. Twist the board quite noticeably and wait for any reaction. Quite often you will see a spark from the faulty joint and the set springs into life. The other approach is to tap the board with the plastic handle of the screwdriver and gradually home-in on the fault.

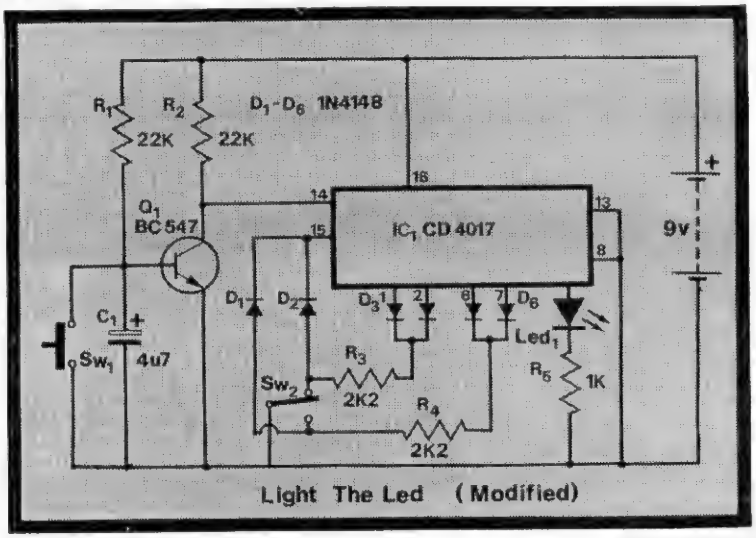
There is no other magic to finding dry joints. These are the general basic rules and provided you keep a mental record of each and every dry joint as you find it, you will build up a skill equal to any expert.

light the led *MODIFIED*

After a couple of requests for help with LIGHT THE LED, we found the de-bounce circuit comprising the two electrolytics at the input of CD 4017, was not good enough. Some brands of IC's were more sensitive and had a tendency to clock two or even three outputs on a single pulse of the switch. No matter how we altered the 2-capacitor de-bounce network, it was not satisfactory. So we designed a different arrangement. This time we employed a transistor to change the state of the input gate from HIGH to LOW. As the 4.7mfd cap charges, the base voltage rises, turning on and saturating the transistor. The voltage at the collector changes from rail voltage to about one volt. This clocks the IC. This circuit works with any CD 4017 and enables the led to light correctly every time. All the parts can be mounted on the PC board without cutting any copper tracks.



Light The Led (Modified)



Light The Led (Modified)

Parts list:

2	-	22k ¼w
2	-	2k2 "
1	-	1k "
1	-	BC 547
1	-	4.7mfd 10v
6	-	1N 4148
1	-	Red 5mm LED
1	-	CD 4017 IC
1	-	Battery clip
1	-	Springy brass strip

10-MINUTE DIGITAL COURSE

IN BLOCKS 1→16 WE SAW HOW AND OR NOT, NAND & NOR GATES FUNCTION.

THIS SECTION SHOWS HOW NAND & NOR GATES CAN BE USED IN FLIP FLOP CIRCUITS.

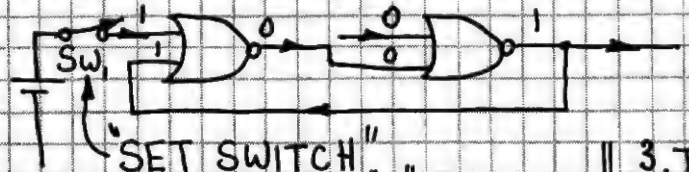
17. THE FLIP FLOP

* HAS 2 STATES: "0" & "1" OR "LOW" & "HIGH".
* CHANGES STATE VERY RAPIDLY.
* CAN HOLD "A PIECE OF INFORMATION".

A SIMPLE FLIP FLOP – CONNECT 2 NOR GATES:

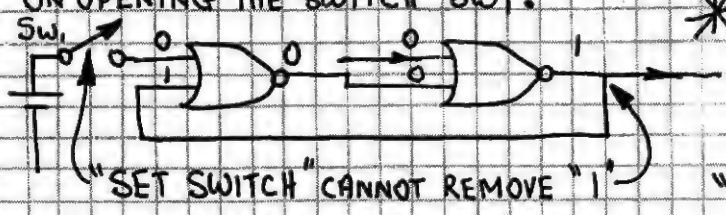
1. INITIALLY THIS GATE HAS "0" ON IT.
2. LET US ASSUME THE BOTTOM INPUT IS ALSO "0".
3. THE OUTPUT OF FIRST NOR GATE WILL BE "1".
4. THE INPUTS TO THE SECOND NOR GATE WILL BE "0" & "1".
5. THE OUTPUT OF THE SECOND NOR GATE WILL BE "0"
6. THIS OUTPUT FEEDS BACK TO THE FIRST NOR GATE.

ON CLOSING SWITCH SW_1:



1. THE SWITCH GIVES A "1" TO THE TOP INPUT GATE.
2. A "0" & "1" ON THE INPUTS MAKES THE OUTPUT CHANGE TO "0"
3. THE SECOND NOR GATE HAS "0" & "0" ON ITS INPUTS, MAKING THE OUTPUT CHANGE TO "1".
4. THIS "1" FEEDS BACK TO THE FIRST NOR GATE.

ON OPENING THE SWITCH SW_1:



* WHEN SWITCH SW_1 IS OPENED THE FIRST NOR HAS "0" & "1" ON ITS INPUTS. THE OUTPUT DOES NOT CHANGE.

THUS WE HAVE REGISTERED:

"A PIECE OF INFORMATION".

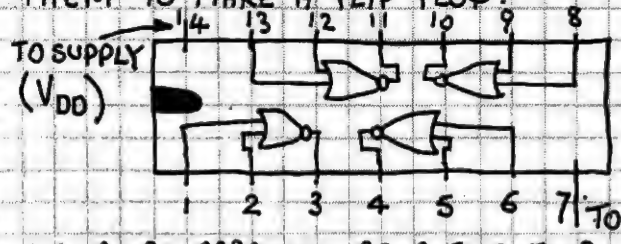
18 TO "RESET" THE SIMPLE FLIP FLOP BACK TO ITS ORIGINAL STATE WE NEED A SWITCH AT THE SECOND NOR GATE.

THE "RESET" SWITCH PUTS A "1" ON THE TOP INPUT OF THE SECOND NOR GATE. THIS CHANGES THE OUTPUT TO "0". THIS FEEDS DIRECTLY TO THE INPUT OF THE FIRST NOR GATE, AND CAUSES ITS OUTPUT TO CHANGE TO "1". THIS CREATES A HIGH ON BOTH INPUTS OF THE SECOND NOR GATE.

ON OPENING THE "RESET" SWITCH:

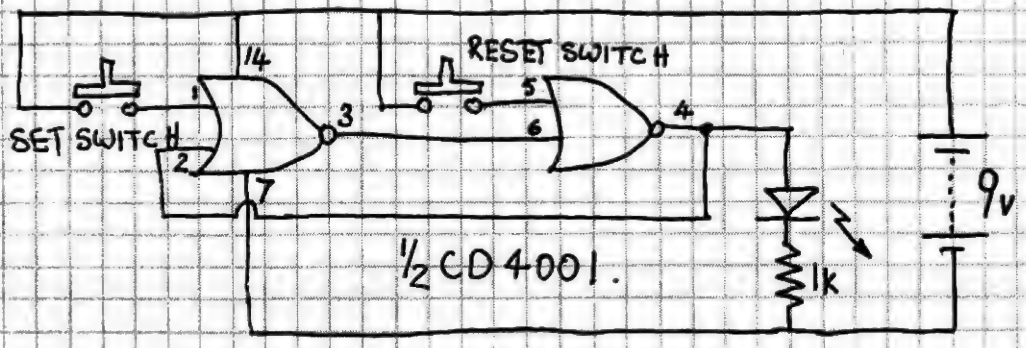
* WHEN THE "RESET" SWITCH IS OPENED THE OUTPUT DOES NOT ALTER & THE RESET SWITCH HAS NO FURTHER EFFECT.

A CMOS CD4001 IC CONTAINS 4 NOR GATES. WE CAN USE ANY TWO OF THEM TO MAKE A FLIP FLOP:



CD 4001 IS A QUAD 2-INPUT NOR GATE.

IT CAN BE ARRANGED AS A FLIP FLOP:

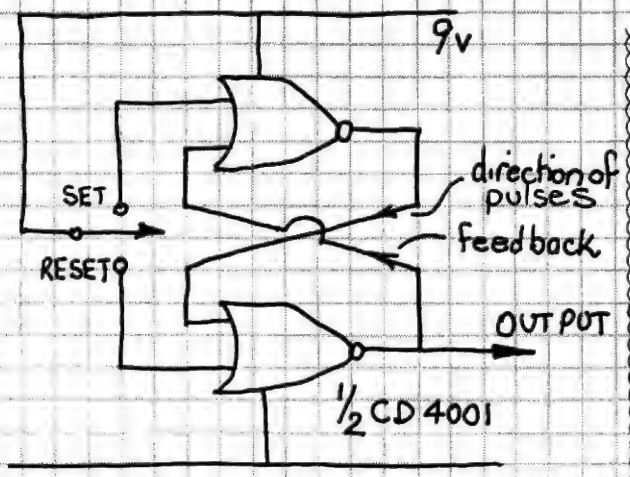


CLOSING THE "SET SWITCH" WILL TORN THE LED ON AND THE "RESET" SWITCH WILL TURN THE LED OFF

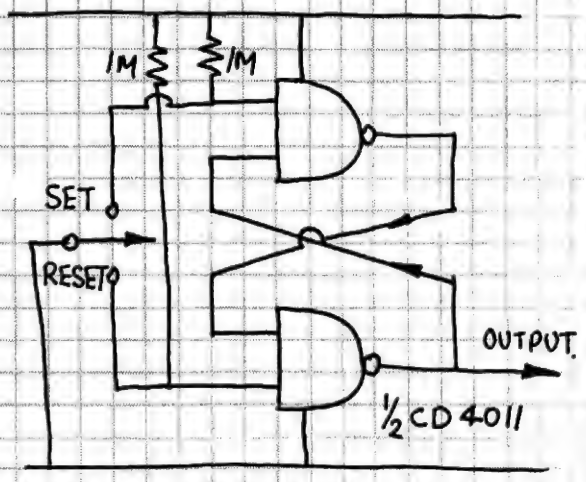
A FLIP FLOP CIRCUIT IS A BASIC BUILDING BLOCK. IT IS REDRAWN IN #19 WITH A SINGLE SWITCH. THE NEW LAYOUT WILL BE EASIER TO UNDERSTAND & FOLLOW.

19

NOR GATE FLIP FLOP:



NAND GATE FLIP FLOP

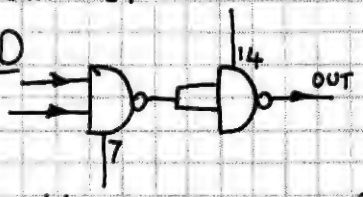


THE FIVE LOGIC FUNCTIONS:

AND
OR
NOT
NAND
NOR

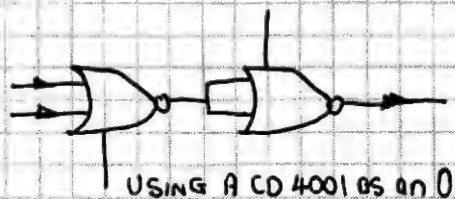
CAN BE PERFORMED BY CD 4001 & CD4011 IC's.

1. AND



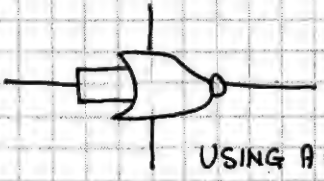
Using a CD4011 as an AND gate

2. OR



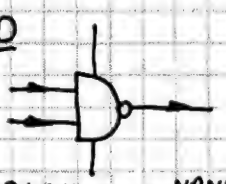
USING A CD 4001 AS an OR gate

3. NOT



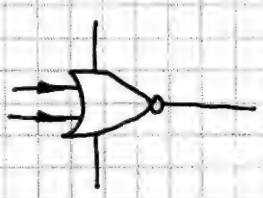
USING A CD4001 AS A NOT.

4. NAND



A CD4011 IS a NAND GATE

5. NOR

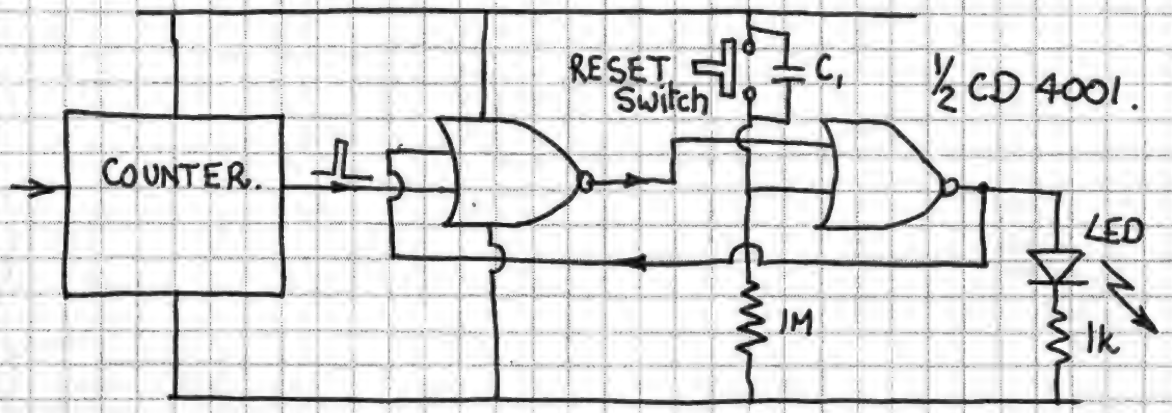


A CD 4001 IS A NOR GATE

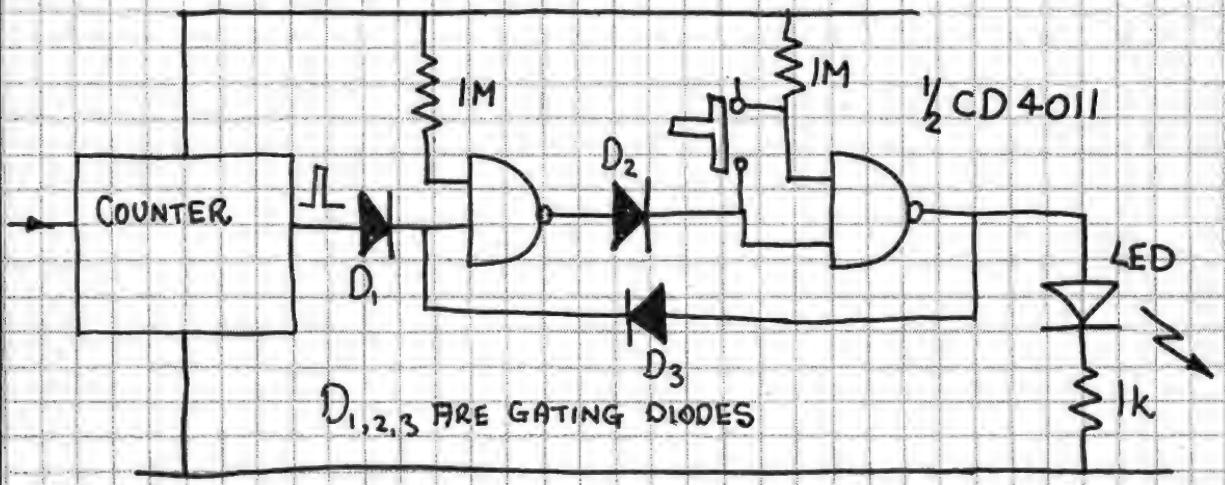
The most useful IC's are NAND & NOR gates. They can arranged to perform all the five basic functions.
With their inverting outputs we can build them into a number of clever switching and latching circuits. These will be described in the next sections.

20 Since SOME PULSES IN ELECTRONICS ARE ONLY PRESENT FOR VERY SHORT PERIODS OF TIME, WE MUST HAVE SOME WAY OF STORING AND RECORDING THEM THE ANSWER IS.....

.... A LATCH — A CD 4001 OR CD 4011 CAN BE USED AS A LATCH.



THE OUTPUT OF THE COUNTER IS NORMALLY "LOW". IT GOES "HIGH" FOR 1 PULSE THEN LOW. THE LED WILL LIGHT & STAY LIT. IT WILL "LATCH ON". THE RESET SWITCH WILL TURN LED OFF.
THE CIRCUIT HAS INDETERMINATE START-UP. BUT WITH C_1 THE CIRCUIT WILL START UP WITH THE LED OFF.



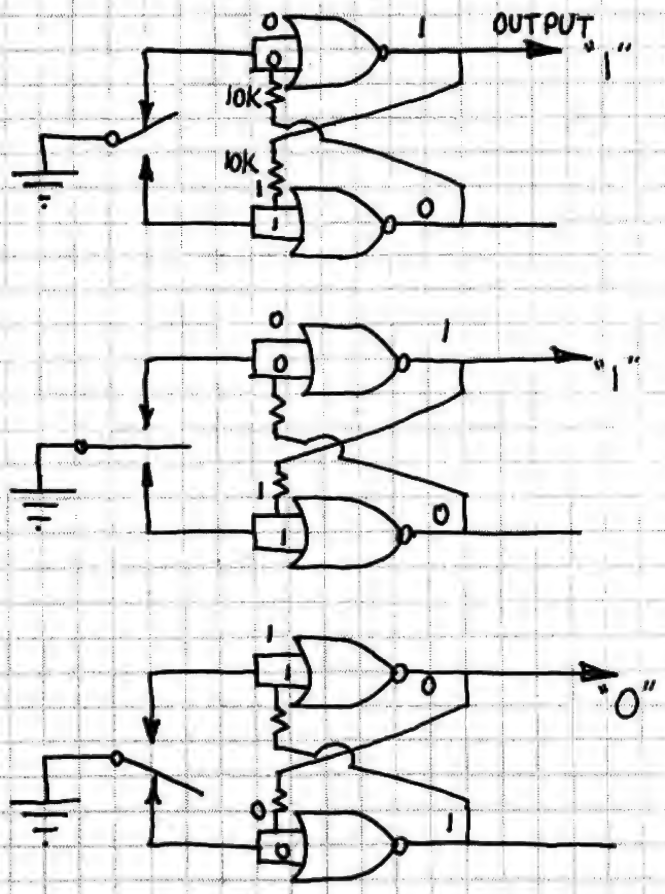
DEBOUNCE SWITCH:

Whenever a mechanical switch is included in a digital circuit there will be problems of "SWITCH BOUNCE". This is due to the contacts striking each other several times before finally closing. Since ICs such as counters and flip flops will record frequencies up to many MHz they will register the opening and closing of a normal switch as several pulses and produce a false reading. To eliminate this problem we can use two NAND gates to form a DEBOUNCING CIRCUIT. In this type of circuit, the states are unaffected by noise, since the states are changed by the first noise pulse from the switch and cross-coupling causes the circuit to self-latch and be immune to further pulses.

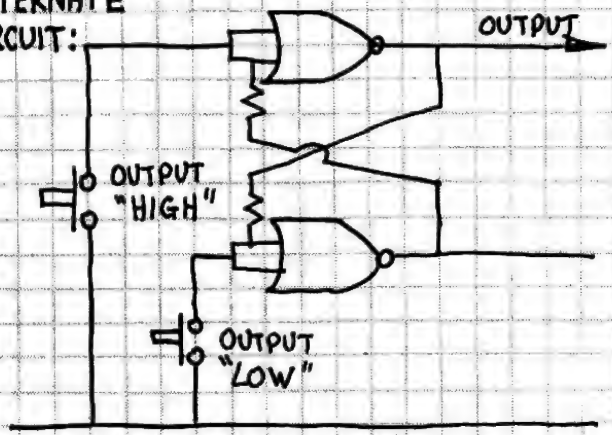
21 ..... DEBOUNCE SWITCH.

THE IMPORTANT POINT TO NOTE IS THE IC DOES NOT CHANGE STATE ON OPENING THE SWITCH CONTACTS, NOR DOES IT CHANGE STATE ON RE-CLOSING THE CONTACTS BACK TO THE SAME GATE.

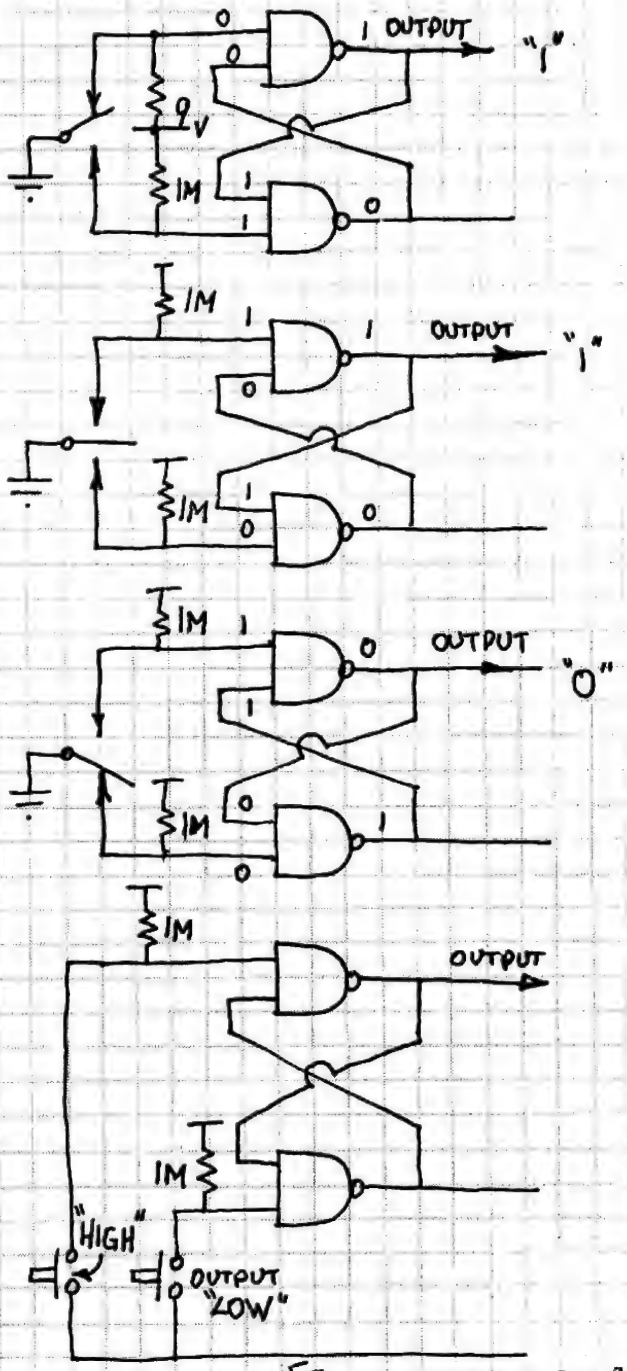
USING A CD 4001 NOR GATE:



ALTERNATE CIRCUIT:



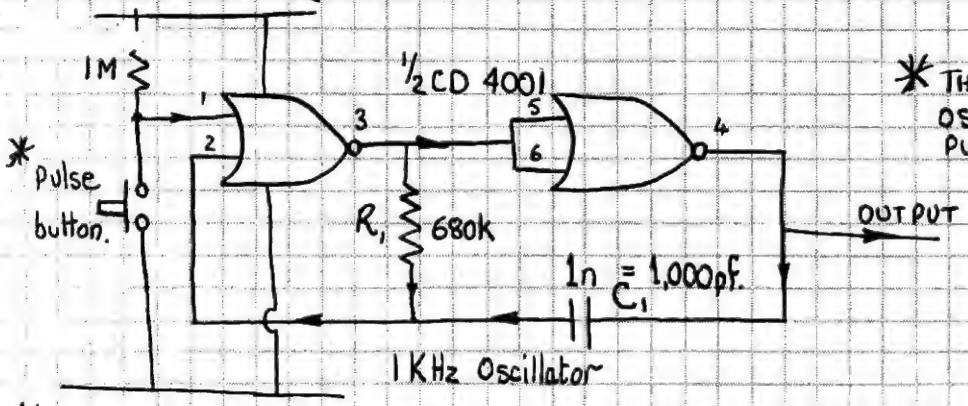
USING A CD 4011 NAND GATE:



[FIND THE MISTAKE ON THIS PAGE]

22 MULTIVIBRATORS:

THE MOST USEFUL MULTIVIBRATOR IS THE ASTABLE OR SQUARE-WAVE GENERATOR. THE CIRCUIT SHOWS ½CD4001 IC USED TO MAKE A 1KHz ASTABLE MULTIVIBRATOR.



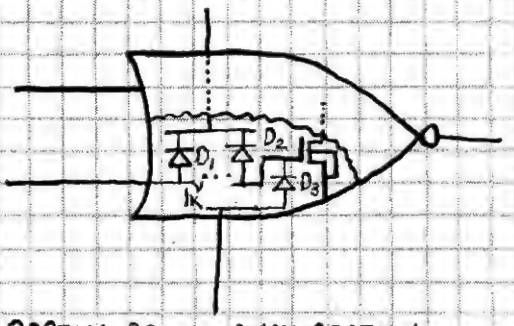
* THE CIRCUIT ONLY OSCILLATES WHILE THE PULSE BUTTON IS PRESSED

HOW THE CIRCUIT WORKS:

THE CIRCUIT IS SHOWN GATED OFF DUE TO PIN 1 BEING BIASED HIGH VIA THE UPPER 1M RESISTOR. [A HIGH ON EITHER INPUT GATE WILL CAUSE THE OUTPUT TO GO LOW]. THUS PINS 3, 5 & 6 ARE LOW. PINS 5&6 ARE THE INPUT GATES OF THE SECOND NOR GATE. AND WILL CAUSE THE OUTPUT PIN 4 TO BE IN A HIGH STATE UNTIL PIN 1 GOES LOW MOMENTARILY.

WHEN A PULSE OF SHORT DURATION IS DETECTED ON PIN 1 IT WILL CAUSE PIN 3 TO GO HIGH AND THE OUTPUT PIN 4 TO GO LOW. SEE TRUTH TABLE FOR NOR GATES TO VERIFY THIS. CAPACITOR C_1 BEING FULLY CHARGED, WILL ATTEMPT TO MAKE PIN 2 SWING NEGATIVE WITH RESPECT TO THE 0v RAIL. LET ME EXPLAIN THIS IN ANOTHER WAY WHICH MAY BE EASIER TO UNDERSTAND. SUPPOSE WE CONSIDER THE CAPACITOR TO BE A 9v RECHARGEABLE BATTERY. INITIALLY THE BATTERY IS IN A STATE OF FULL CHARGE. WHEN A TRIGGER PULSE IS RECEIVED AT PIN 1 THE FIRST NOR GATE WILL GO HIGH AND SINCE IT IS DIRECTLY COUPLED TO THE SECOND NOR GATE IT CAUSES THE OUTPUT PIN 4 TO GO TO 0v. THIS IS EQUIVALENT TO UNPLUGGING THE FULLY CHARGED BATTERY AND PLACING ITS POSITIVE TERMINAL ON THE 0v RAIL.

IN BUILT INTO EACH GATE OF THE IC ARE 3 DIODES, ONE OF WHICH PREVENTS THE INPUT SIGNAL GOING BELOW 0v (the other two are discussed later). SO WHEN THIS −9v IS PRESENTED AT INPUT GATE 2, DIODE D_3 CONDUCTS VIA THE 1k RESISTOR AND QUICKLY REMOVES THE CHARGE ON THE CAPACITOR (OR BATTERY ANALOGY). WITH THE CAPACITOR FULLY DISCHARGED, IT BEGINS TO RECHARGE IN THE REVERSE DIRECTION FROM THE HIGH ON PIN 3, VIA R_1 AND THE VOLTAGE ON PIN 2 STARTS TO RISE EXPONENTIALLY TOWARDS THE POSITIVE RAIL. DURING THIS RISE THE TRANSFER VOLTAGE IS ATTAINED AND CAUSES THE OUTPUT PIN 3 TO GO LOW AND PIN 4 TO GO HIGH.



PARTLY BROKEN AWAY SECTION SHOWING THE 3 INPUT PROTECTION DIODES CONNECTED TO EACH GATE.

TEST YOURSELF... No 2

How good are you at identifying capacitors? This quick test will give you a rating.

CAPACITORS ..

Capacitors come in so many shapes and sizes. They have at least 3 different identification codes and sorting them out can be quite difficult. This can be a problem as their size bears no relationship to their value, rating or type of constructional material. So let's see how much you know....try this test and give yourself a rating. The marks for each question do not relate to their difficulty.

1. Name 5 types of capacitors:

   A: (No cheating now)

   B:

   C:

   D:

   E: (10)

2. Draw the symbol for:
   (a) A capacitor:

   (b) An electrolytic:

   (c) A variable capacitor:

   (d) A non-polar 10mfd electro:

   (8)

3. Explain with words or a drawing:

   (a) green cap:

   (b) PC mounting:

   (c) RT or PT leads:

   (d) "styro":

   (e) 

   (f) "poly":

   (8)

4. Arrange these capacitors in approx order of size: small,med,large:

   (a) 1mfd 63v ceramic.....( )
   (b) 1mfd 63v electrolytic..( )
   (c) 1mfd 63v paper.....( )
   (d) 1 mfd 63v polyester....( )
   (e) 1mfd 63v tantalum.....( )

   (3)

5. List all the values of capacitors between .001mfd and .027mfd:

   (16)

6. Can you give a simple explanation why these three electrolytics will be about the same physical size:

   1mfd 350v
   10mfd 35v
   100mfd 3.5v (2)

7. An electrolytic can suffer from at least 3 main faults. Can you name them:

   (a)

   (b)

   (c) (3)

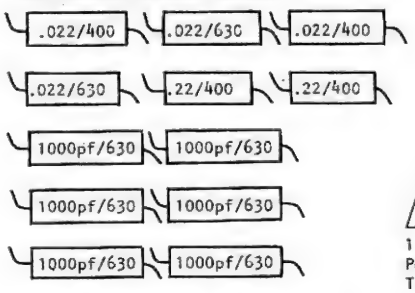
8. Draw:

   (a) 2 capacitors in series:

   (b) 2 capacitors in parallel:

   (2)

9. Almost any value of capacitance can be created by joining caps in series or parallel or a combination of both. In addition, high-voltage ratings can be achieved with this method.

   With the above set of capacitors, create these values:

   (a) .47mfd/400v

   (b) 500pf/400v or higher

   (c) 100pf/1Kv or higher

   (d) .01mfd/1Kv or higher

   (8)

10. When choosing an electrolytic, why should its rated voltage be close to its working voltage?

    (2)

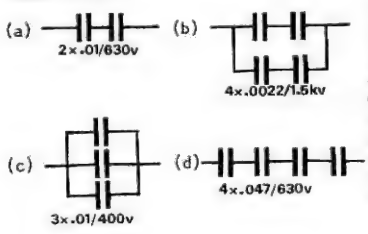
11. What is the advantage of a tantalum (and the new tantalum equivalent) over ordinary electrolytics?

    (4)

12. Would you use a ceramic capacitor as a timing capacitor? (the frequency setting capacitor in an oscillator circuit)

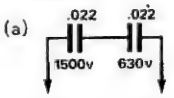
    (2)

13. What is the value of these combinations:

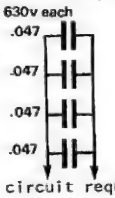
    

    (8)

14. Explain the fault with these arrangements:

    (a) 

    circuit requires .01/2Kv

    (b) 

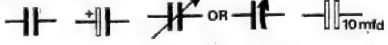
    circuit requires .22/2Kv

    (4)

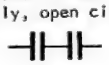
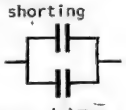
Total: 80marks.

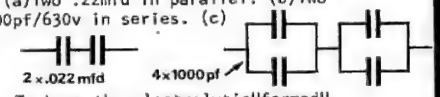
Answers:

1. Paper, Ceramic, Polystyrene, air, Polycarbonate, Polyester, Electrolytic, Tantalum, Mica.

2. 

3.(a)the name given to a style of polyester capacitor using green resin coating. (b)Printed Circuit Mounting with both leads at one end.(c)Rat Tail, PT=Pig Tail - where one lead emerges from each end. (d)Polystyrene (e)N:style number which does not involve us. 630:the working voltage .68:the capacitance in mfd K:tolerance which is +10% (f) Polypropylene or polyester. 4.Approximately the paper will be the largest,then polyester,ceramic,electrolytic and tantalum the smallest. 5..0012,.0015, .0018,.0022, .0027, .0033, .0039, .0047, .0056, .0068, .0082, .01, .012, .015, .018, .022. 6. A factor obtained by multiplying the capacitance and the voltage will give the size of an electrolytic. 7. Drying out and losing capacitance, intermittent connections to the leads, shorting internally, open circuit.

8. (a)  (b) 

9. (a)Two .22mfd in parallel. (b)Two 1000pf/630v in series. (c) (d) 

10. To keep the electrolytic"formed" 11.smaller size, lower leakage current. 12.No,never. 13.(a)4n7/1kv (b)2n2/ 3kv (c)33n/400v (d)12n/2.5kv 14.The capacitance is correct but the voltage will be equal across each capacitor so that 1kv will appear across the 630v cap. (b)The cap. is correct but the voltage rating of the combination is still 630v. Thus 2kv will appear across the 630v capacitors.

score:

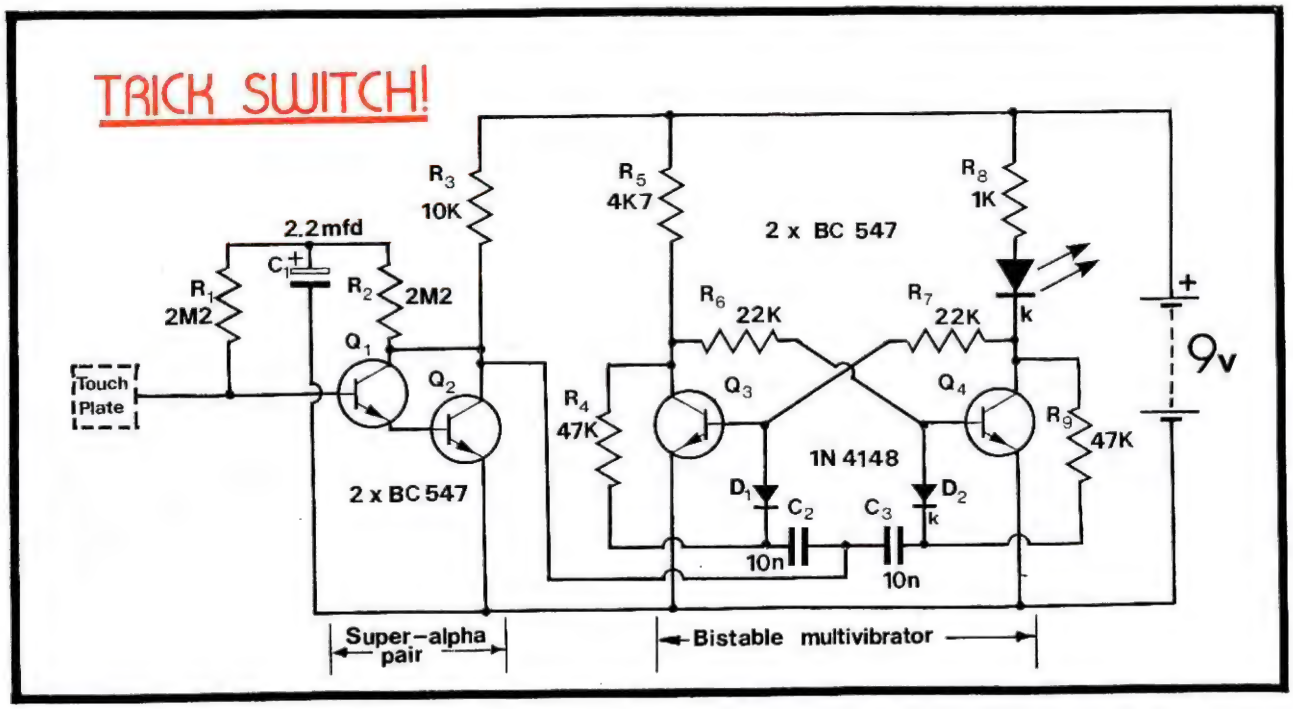
Over 70 marks	-	Excellent
over 60	-	Very Good
over 50	-	Good
below 50	-	Not a pass

THE TRANSISTOR PAGE

"So? What's the trick?" you ask. "The circuit looks perfectly normal to me".

When you build up the circuit you will find the switching plate, called a TOUCH PLATE, has only ONE wire connecting it to the circuit. Now anybody with even the slightest idea of electrical circuits knows you need two wires for a switch to operate. Thus the trick. We need only ONE wire!

Transistors Q_3 and Q_4 make up the second building block and form a BISTABLE SWITCH or BISTABLE MULTIVIBRATOR. This means it has two states and requires triggering into each state. This circuit does not possess any frequency of its own but will flip from one state to the other at a rate determined by the pulses arriving at C_1,C_2. A red LED provides the load for transistor Q_4 and when the TOUCH PLATE is touched with your finger it will start the LED flashing at about 25Hz or so



Unfortunately nearly everyone also knows about touch controls. We see them in lifts and touch pads to open doors so the day may be nearly past when a one wire touch switch has any real impact. Anyway it does provide a neat project with potential for experimenting and you may find a new use for a touch plate in the process.
This circuit does not have a "one touch and it's on" or "one touch and it's off" ability as the random chance of the LED finishing up lit is 50%.

HOW IT WORKS:

The TRICK SWITCH uses 4 transistors to create two individual building blocks.
The first two transistors form a DARLINGTON PAIR (super-alpha pair) in which the gain of the circuit is very close to the product of the two transistors. When you touch the TOUCH PLATE with your finger, your body is acting like an antenna, picking up stray hum similar to the noise you get when you touch the input of am amplifier. This 50Hz hum is amplified sufficiently by the two transistors to trigger the second section.

according to the frequency of the stray hum. When your finger is removed the LED will immediately settle into one of its two conditions. Either fully 'ON' or fully 'OFF'. Since the components surrounding Q_3 and Q_4 are of equal value, the chance of the LED remaining lit is 50%.

To provide guaranteed triggering for the bistable section, two steering diodes are included. Their operation is as follows: Suppose the circuit is in one of its two stable states with Q_3 cut-off and Q_4 conducting. This means that diode D_1 will have a positive voltage on its cathode via R_4 and R_5 and the anode will be brought to ground via the 22k resistor R_7. This diode will be reverse biased. Diode D_2 will have its cathode near ground potential via the 47k resistor R_9 and its anode near positive potential via R_6 and R_5. This diode will be forward biased. The placement of the two steering diodes makes them only capable of turning off their respective transistor. This means that the next pulse appearing through capacitor C_2 can have no effect on transistor Q_3 since it is already cut-off but a negative-going

pulse through C_3 will remove the forward bias on Q_4, via diode D_2, and turn off the transistor. The voltage on its collector will rise and turn on Q_3. Thus the circuit will change state sharply and remain in this state until a suitable negative-going pulse causes it to "flop".

CONSTRUCTION:

The circuit contains no critical-value components and almost any NPN transistors will be suitable. The resistors need not be the exact values shown in the diagram. You can use any value resistor either side of the one specified provided you keep the symmetry between the two bistable multivibrator transistors so that the "mark-space" ratio will be equal and the chance of the LED being left illuminated kept at 50%.

Build the circuit on a small piece of veroboard. A handy size to buy is 15 holes x 81 holes which can be cut to length for a number of different projects. If you lay out the parts carefully, you will not have to cut any of the copper tracks; a very awkward and messy operation if you don't have the spot-face cutter.

Footnote:

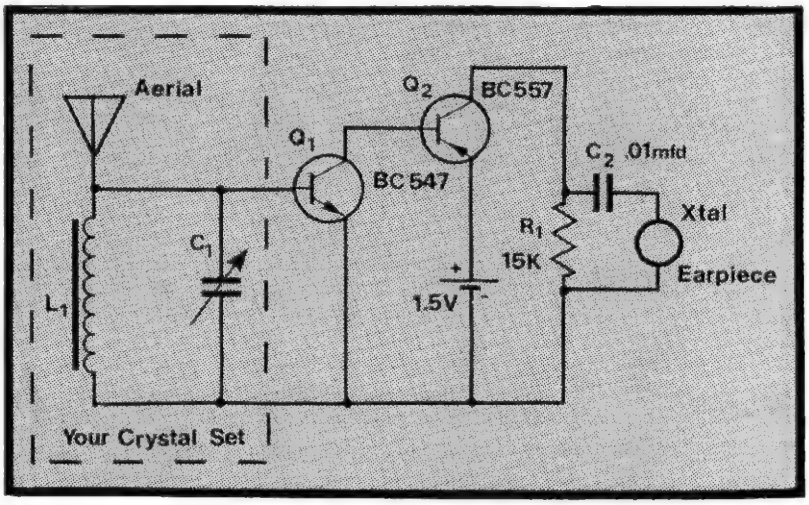
Actually the TRANSISTOR PAGE is designed to highlight the inefficiency and complexity of building circuits with transistors. This TRICK SWITCH is a perfect example. The same effect can be performed with one simple 50c IC and just 7 external components! Consider the speed in assembling 8 parts compared to the TRICK SWITCH circuit with its array of transistors, resistors, diodes and capacitors.

Hopefully you will be gradually weaned off transistor projects and onto "little black packages". For the moment we will use the TRANSISTOR PAGE projects as an insight into the operation of various modules or building blocks. Consider them purely as this. Any circuits you wish to build should utilize spare or used components to keep construction cost to a minimum and justify their assembly.

AMPLIFY!

your crystal set

Build this simple two transistor amplifier for your crystal set and pull in the weaker stations. This circuit will operate with almost any type of transistors and will surprisingly still keep functioning when the battery is dis-connected. Since it takes so little power we have not included a switch. When the power is applied, the transistors amplify the signal considerably and you may even be able to drive a small 15ohm or 33ohm speaker if the voltage is increased to 6v.



Almost any crystal set can be used. The only part you need to remove is the crystal itself. Its function is performed by the first transistor. Crystal sets can be roughly divided into two groups. Slug tuned coil types and variably capacitor types. The first has a coil of wire wound on a former in which a ferrite rod is allowed to slide. This rod varies the "Q" of the coil and thus alters the frequency at which the circuit will resonate. This coil is used in conjunction with a fixed capacitor of about 400 - 500pf. Unfortunately the effectiveness of this circuit diminishes as the rod comes out of the coil. This is overcome by having a fixed aerial coil& rod assembly and adjusting the capacitance in the circuit. Open up your crystal set and take a look inside. It will not matter which type you have. They will both work equally well with this high gain amplifier. All the parts will fit inside the crystal-set container without the need of a tag strip. Try to make a neat "birds-nest" soldering job.

Good Luck!

....Continuing our series on the

EXPERIMENTER DECK

HEADS or TAILS?

PROJECT TWO

This project adds a further 9 parts to the HEE HAW SIREN to make our 2-LED readout "HEADS OR TAILS". You must complete the HEE HAW first and have it operating correctly before starting this project. This way you are testing your workmanship in stages...its no good completing a project to find it doesn't work.

THE ORIGIN OF HEADS OR TAILS

In days gone by, players would toss a penny to see who would commence playing a game. This custom is still carried on in cricket. When pennies were in full circulation, one of the simplest games in the world used a penny as the sole betting medium. Although highly illegal, groups or sharp, daring punters would gather behind deserted buildings to play what they called "the fairest game in the world"...TWO-UP. It consisted of tossing a penny in the air and while it is spinning high above their heads, a punter would place a bet on it landing on the ground either heads or tails. A penny was used not only for its large size but because they knew the chances of it landing heads was exactly 50%.

Since there aren't any pennies around today, (and 20c coins are just "not the same") you can make your own heads or tails predictor with the aid of electronics and learn about the laws of chance.

PARTS

R5	Resistor	10K
R7	"	4K7
R8	"	4K7
R9	"	120R
2	-	5mm Red LEDs
2	-	diodes IN 4148
IC_2		CD 4017
5	-	Molex pins

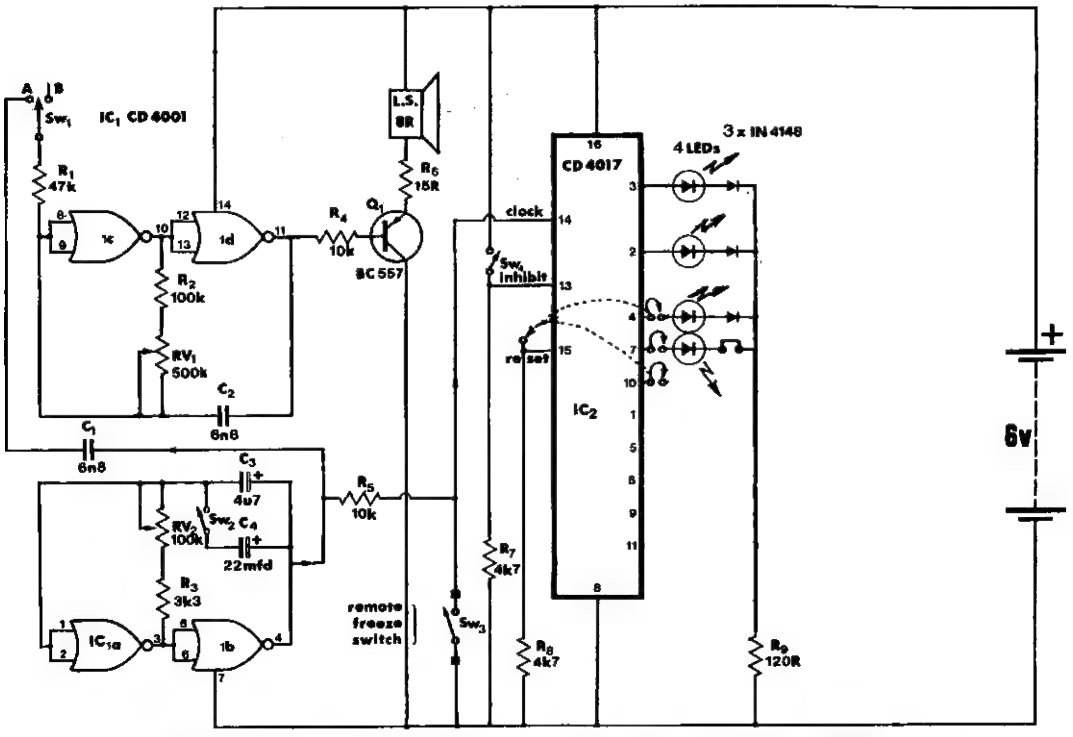


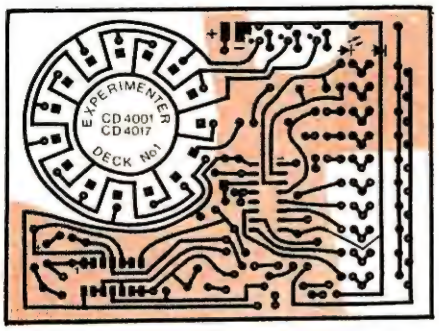
fig.2&3 HEADS or TAILS – use 2 LEDs
DECISION MAKER – use 4 LEDs

This circuit is designed to have no bias, meaning it doesn't tend to favour one LED or the other. This means it can be used with confidence, which is more than could be said about the reliability of a "TWO-UP SCHOOL"...as they used trick pennies, and fluttering instead of spinning the coin!

MOUNTING THE PARTS

Solder the CD 4017 carefully onto the board with pin1 passing through the correct hole. Use your fingers as a heat-sink. Follow the layout diagram to locate the positions of the 4 resistors, 2 LEDs and 2 diodes. The LEDs and diodes must be inserted around the correct way or they will not operate. Don't heat up the LEDs excessively while soldering as this will destroy their brightness. Make up 4 jumper leads from 5cm lengths of hook-up flex. Tin both ends of each lead and solder them in positions marked "J". On the jumper lead nearest the CD 4017, solder a flying Molex pin to the lead. Fit a Molex pin to the PC board in the three positions shown. Cut two short resistor leads and insert them into the board in positions marked "W". The flying Molex pin will fit onto either of these wires to form Sw4, the clock inhibit switch. For projects 2 & 3 it is moved from wire W_2 to W_1 to freeze the output.

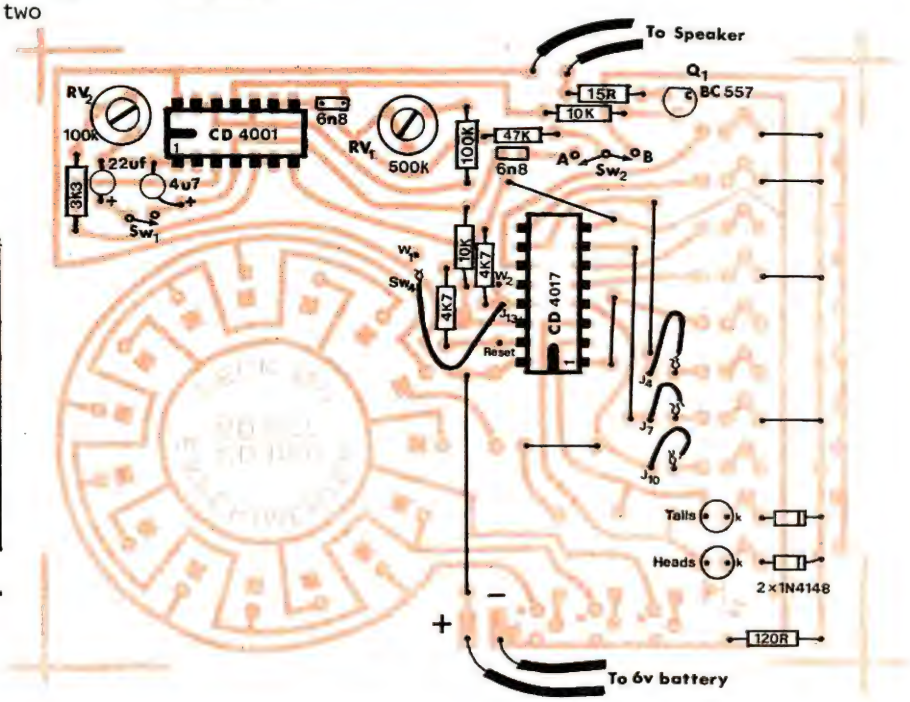
For project 2 the reset jumper J_4 is connected onto the Molex pin near IC_2. This will allow only the first two outputs to become activated.



Shaded area covers the soldering for projects 1,2&3.

HOW THE CIRCUIT WORKS

The CD 4017 is a counting IC. We are using only two of its outputs in this project. The first output is pin 3 and the second output is pin 2. It has a further 8 outputs which are not used in this project. They are by-passed by using the reset pin number 15 as follows: The third output pin 4 is connected back to the reset pin so that the IC will clock from pin 3 to pin 2 then back to pin 3 again.
The input pin 14 counts the incomming pulses from the flip-flop $IC1_a$ and $IC1_b$. By rotating R2 to minimum resistance the frequency will be about 24Hz. This is the highest frequency obtainable from the flip-flop. Its range starts from one cycle per 9 seconds to 24 cycles per second. The counting IC accepts this and displays the pulses alternately at pins 3 and 2. This means each LED will flash at 12 times per second In fact it will look as if both LEDs are glowing dimly.
The IC has another feature built into it at pin 13. This is called the "clock inhibit" pin. Its function is to "freeze" the output at any given instant. It comes into operation when a voltage above about 4v is applied to pin 13.
To obtain positive freezing or clocking we apply either full rail voltage or zero voltage to this pin. In this project we use this "freezing" facility to give us a readout of either heads or tails. At the rate of 12 flashes per second you will be unable to deliberately stop the motion of a particular LED due to the cycling being higher than the Persistence of Vision. (Which is about 5-6Hz). Thus the freezing of either LED will be completely at random and since both LEDs are clocked on and off at an equal rate, (50% duty cycle each), there will be no bias towards either.

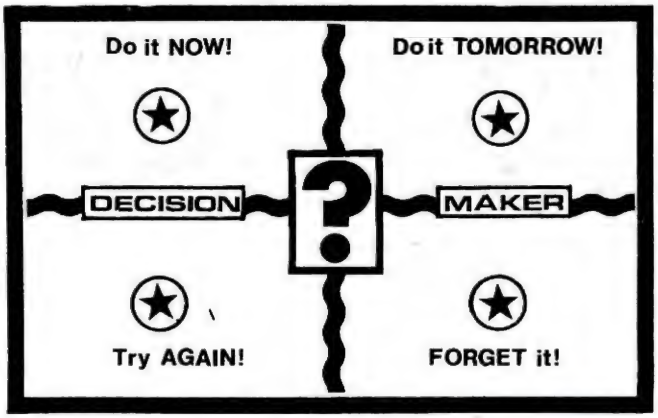


HEADS OR TAILS LAYOUT

DECISION MAKER

PROJECT THREE

This is a simple extension to HEADS or TAILS. It uses the first four outputs of the IC. At the moment this project may not seem very exciting. Mainly because we have not high-lighted it but it must have appeal in the community as 100's of Decision Makers have been sold @ $29.95. Why would you buy a decision maker? Possibly because we all like decisions to be made for us. Especially when the decision is favourable. That's why you'll like this project. On the surface it looks like an ordinary four-readout display and you would think it gave you a 50/50 chance of arriving at a favourable decision. But on closer inspection you find you have only 25% chance of landing on the LED marked "DO IT NOW". The more alternatives that are provided in the readout will lessen your chance of being stuck with the task.



Use this DECISION MAKER display card if you intend to build the project permanently in a zippy box. The LEDs fit in the centre of each quadrant. In a future issue a special printed circuit board will be designed to fit below the display to produce a smaller and neater project. An on/off switch would need to be included in the circuit to conserve the battery.

DECISION MAKER PARTS

ADDITIONAL PARTS NEEDED

2 5mm LEDs

1 diode 1N 4148

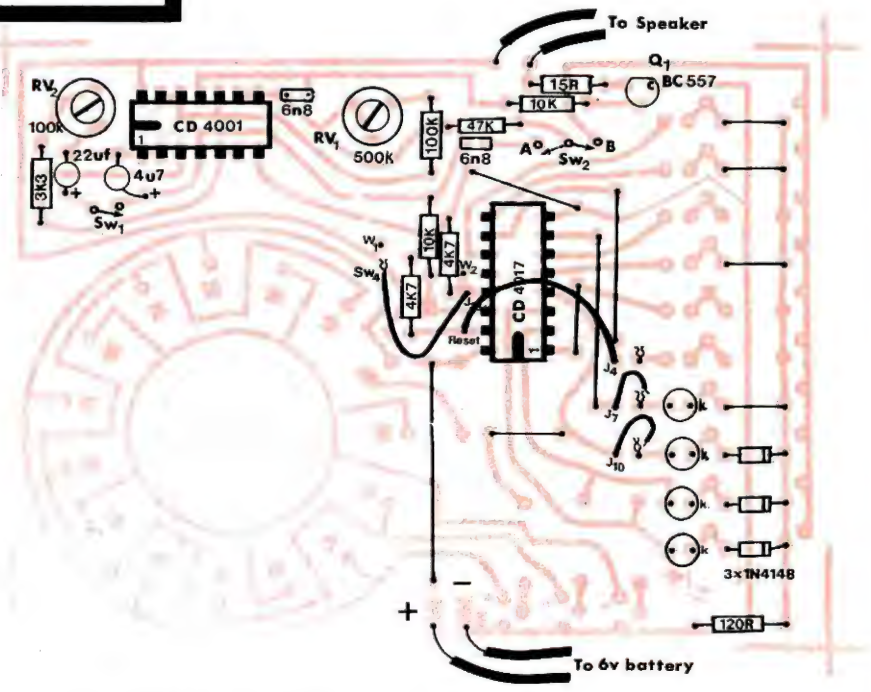
MOUNTING THE PARTS

The three parts are mounted in alignment with the other two LEDs. The reset jumper J_4 is returned "home" and J_{10} is used as the reset jumper.

HOW THE CIRCUIT WORKS

As mentioned before, the CD 4017 is a counting IC. This time we are using four of its outputs. It will clock each of these in turn allowing the 24Hz incomming frequency to be evenly distributed between the outputs to register six cycles per second on each LED. This frequency is sufficiently low enough for you to be able to see slight flickering, however you will not be able to stop the motion on a particular LED. To freeze the LEDs you will need to move the clock inhibit jumper Sw_4 from W_2 to W_1. This will stop the motion instantly. Whether you go by the decision of this game will reflect your acceptance of "things electronic". You will always be able to come back to this game after completing the 10 projects.

DISPLAY CARD



DECISION MAKER LAYOUT

RUNNING LIGHT

PROJECT FOUR

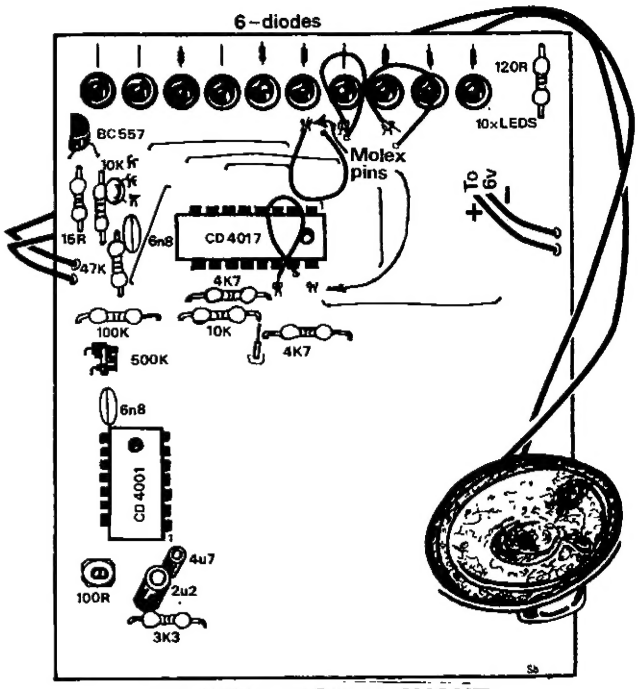
PARTS

5 - 5mm Red LEDs
1 - 5mm Green LED
3 - IN 4148 diodes

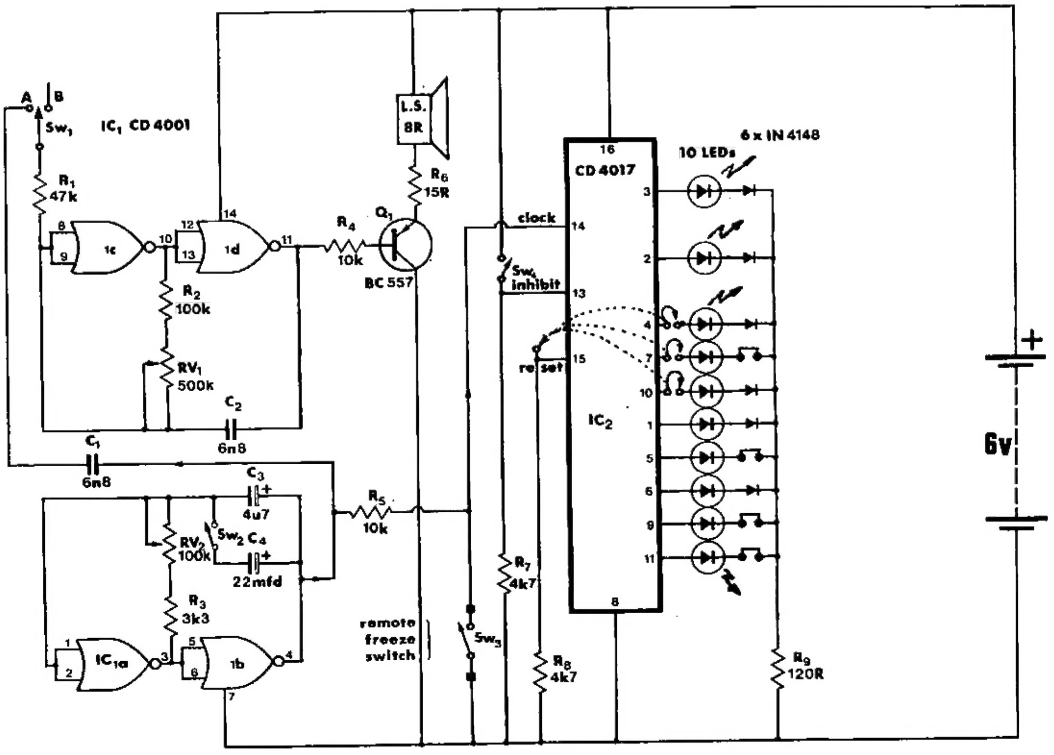
The RUNNING LIGHT project shows the full sequence of the CD 4017 counter. It uses all the 10 outputs to drive 10 LEDs. The IC turns each output on and off in turn to give the effect of a RUNNING LIGHT. Depending on the frequency of the incomming signal, the light will seem to travel at varying speeds. In a darkened room, this effect is most interesting. After watching it for some time, you will be quite convinced a single LED is moving across the PC board. Our eyes are wonderful image-makers. An old saying goes "Believe nothing of what you hear and only half what you see", holds true for this effect.

MOUNTING THE PARTS

The 6 LEDs and 3 diodes are connected in alignment with the 4 LEDs from the DECISION MAKER project. All the jumper leads should be "home" to allow the IC to clock the full 10 outputs. If you have one green LED, it should be positioned as LED number 9 as the next project uses it to record a score or "hit".

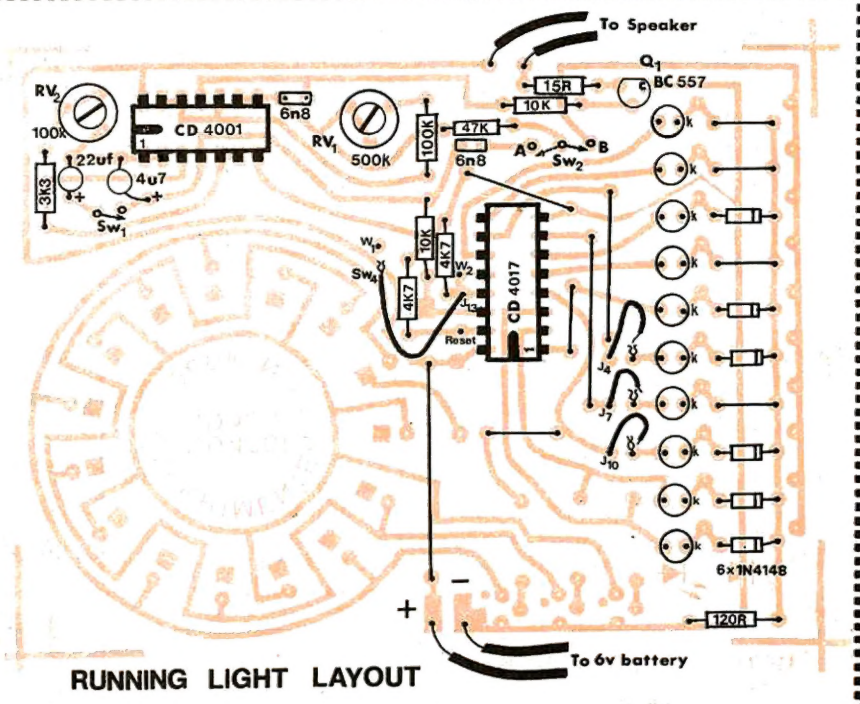


RUNNING LIGHT LAYOUT



The idea behind this project is to give the constructor (that's YOU!) a starting-point for additional experimenting. I wouldn't put the RUNNING LIGHT project away until I had extended its function to say 2 CD 4017's or even putting 40 LEDs in series-parallel to make a square 10 LEDs by 10 LEDs. An even more exciting display combines 2 rows of 10 LEDs wired in opposite directions. The variations are enormous.
Anyone creating a visually exciting or tricky display is invited to send it in for publication. This would fit in ideally with our format. We like to keep extending our projects as this is the most economical approach to circuit construction.

Keep the remainder of the kit of parts for the next episode...to be released next issue.



RUNNING LIGHT LAYOUT

Removing IC's...

One day the time will come when you want an IC for a new project and the only one available will be firmly soldered into a PC board. What do you do? You don't have a desoldering iron or solder sucker or even de-solder wick. It may seem an impossible task but it is possible to remove the IC without completely over-heating it so that it can be re-used.

Unfortunately, in the process, you will ruin the PC board but that's preferable to overheating the chip, or not getting it at all.
Firstly you will need a small piece of ALFOIL to fit tightly over the IC and short all the pins together. This will stop static or leakage from the soldering iron affecting the input gates. It's best to mount the PC board in a clamp or holder because you will need both hands free to work on the de-soldering. Surprisingly enough you will need some solder for the task. I also suggest a constant-heat soldering iron and definitely not a "quick-heat" type as you will tend to overheat the joint in your enthusiasm to get the job done quickly. Begin at pin one with the soldering iron and small screwdriver or pliers. Carefully lever the solder land off the PC board with driver and heat from the iron leaving the pin free of any obstructions. To avoid overheating the IC, the maximum time allowed for each pin is 4 secs. Actually applying a little fresh solder will aid in lifting the land quickly.

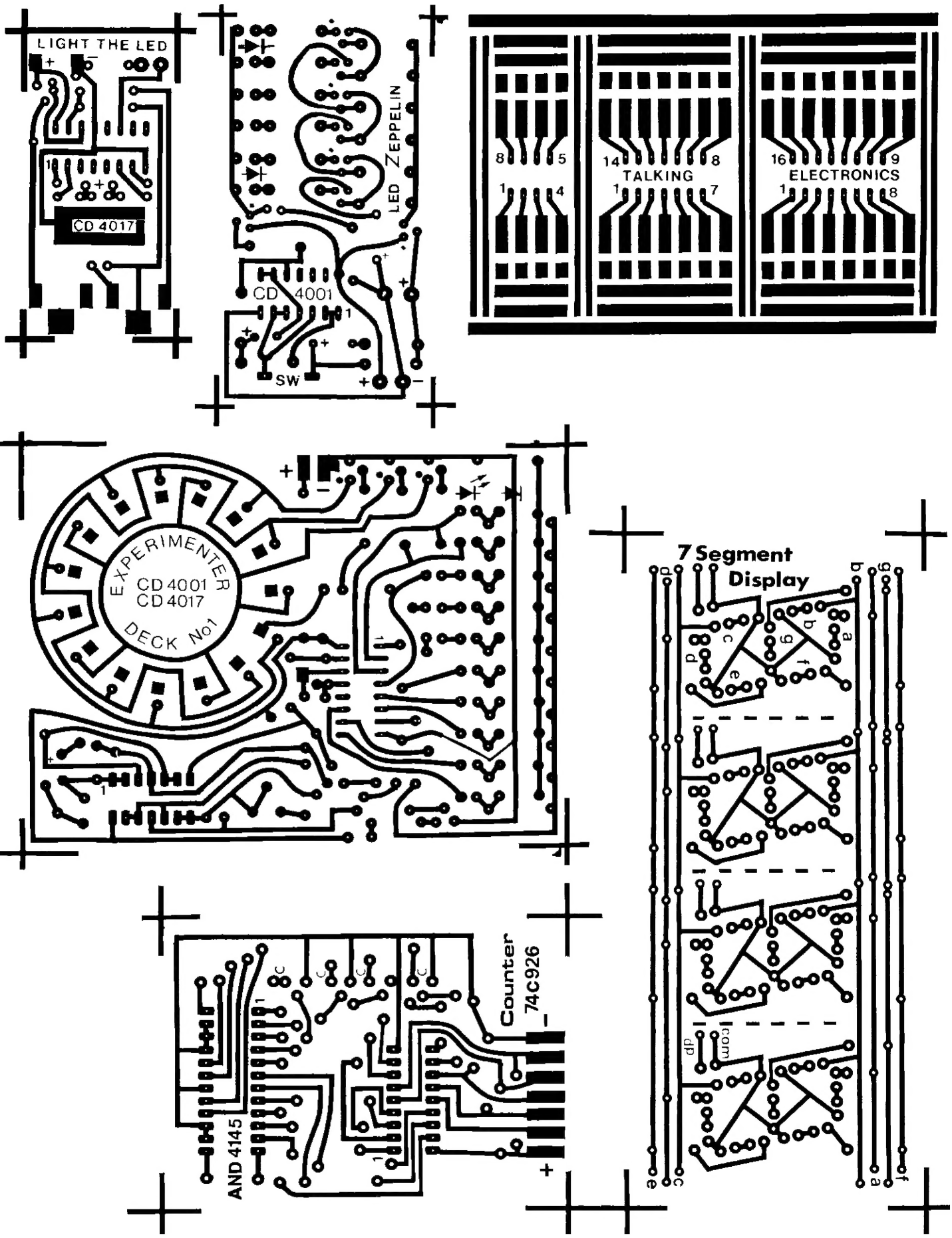
Next select a pin on the other side of the IC to reduce heat build-up. After a great deal of careful prying and lifting you will gain yourself ONE second-hand IC! It may be worth it, it may not. At least you will come to one conclusion. Why didn't I use a socket! My greatest achievement along these lines was to desolder forty-seven 16 pin IC's from a **double-sided** board programming a paper-bag making machine....and replacing them with NEW IC's. After 4 hours solid....it worked!

Quiz:

For the first time, can you see yourself really getting somewhere with electronics?

1. Draw these gates: NAND, OR, NOT, AND, NOR.
2. Explain: V_{SS} V_{DD}
3. The numbers have rubbed off your CD 4017 and CD 4001 IC's. Using only a multimeter, how can you find the CD 4001?
4. A 555 oscillator is running too fast. Would you increase the value of C?
5. What is a "pull-up" resistor?
6. List 4 NEW items learnt from this issue:

_____
_____
_____
_____
_____
_____
_____


LIGHT THE LED
CD 4017
CD 4001
SW
LED ZEPPELIN
TALKING
ELECTRONICS
EXPERIMENTER
CD 4001
CD 4017
DECK No1
7 Segment
Display
Counter
74c926
AND 4145

DATA

Sheet No.2.

CAPACITOR:

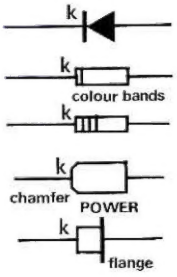
mfd = microfarad
pf = picofarad
n = nanofarad

1000pf = 1n
1n = .001 mfd
1000n = 1 mfd
2n2 = .0022 mfd
22n = .022 mfd
220n = .22 mfd

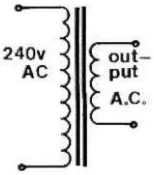
102 = 1,000pf
103 = 10,000pf
= .01 mfd
104 = .1 mfd
105 = 1 mfd

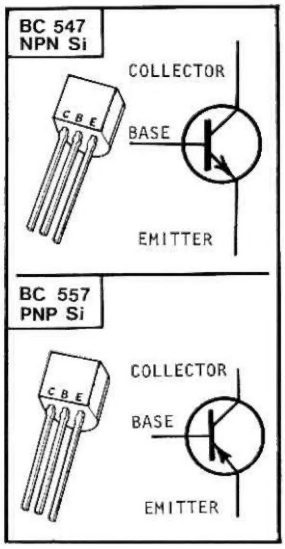
472 = .0047 = 4n7
473 = .047 = 47n
474 = .47 = 470n

DIODE:

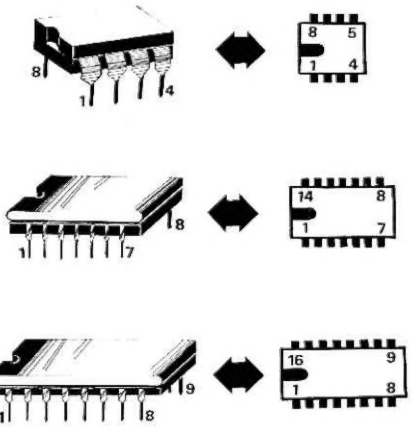


TRANSFORMER:





IC PIN NUMBERS:

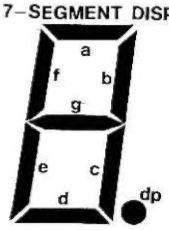


USING A MULTIMETER TO FIND PNP or NPN:

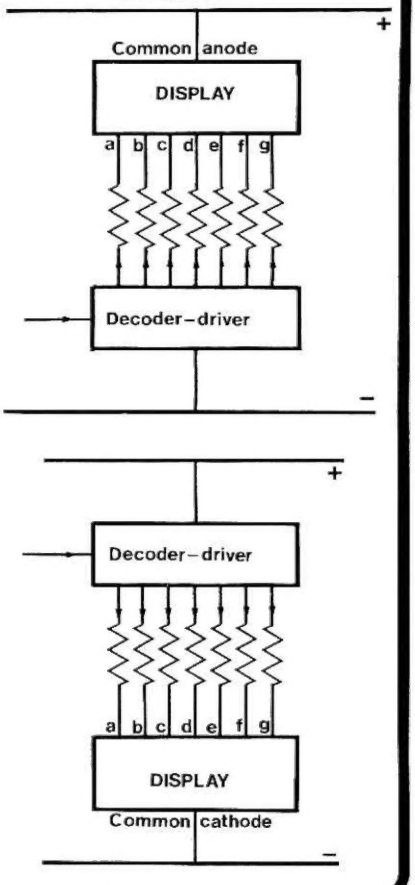
1. Clip meter -ve lead onto centre lead of transistor.
2. Set multimeter to high ohms (x1k range)
3. Positive lead to outer pins reads:
   HIGH-HIGH IT's PNP
   LOW-LOW IT's NPN

If "B" unknown - use transistor tester on Page 27 of issue No1.

7-SEGMENT DISPLAY

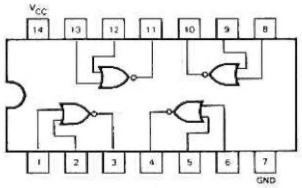


WIRING DISPLAYS:

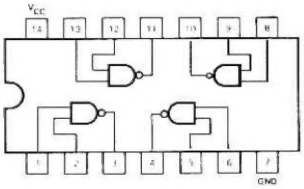


PIN OUTS:

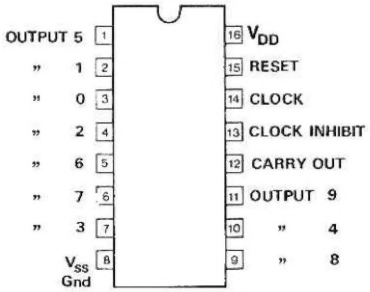
CD 4001



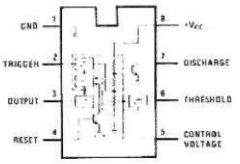
CD 4011



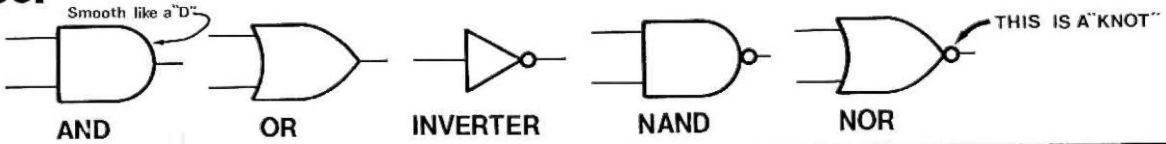
CD 4017



555



Gates:



CPW

